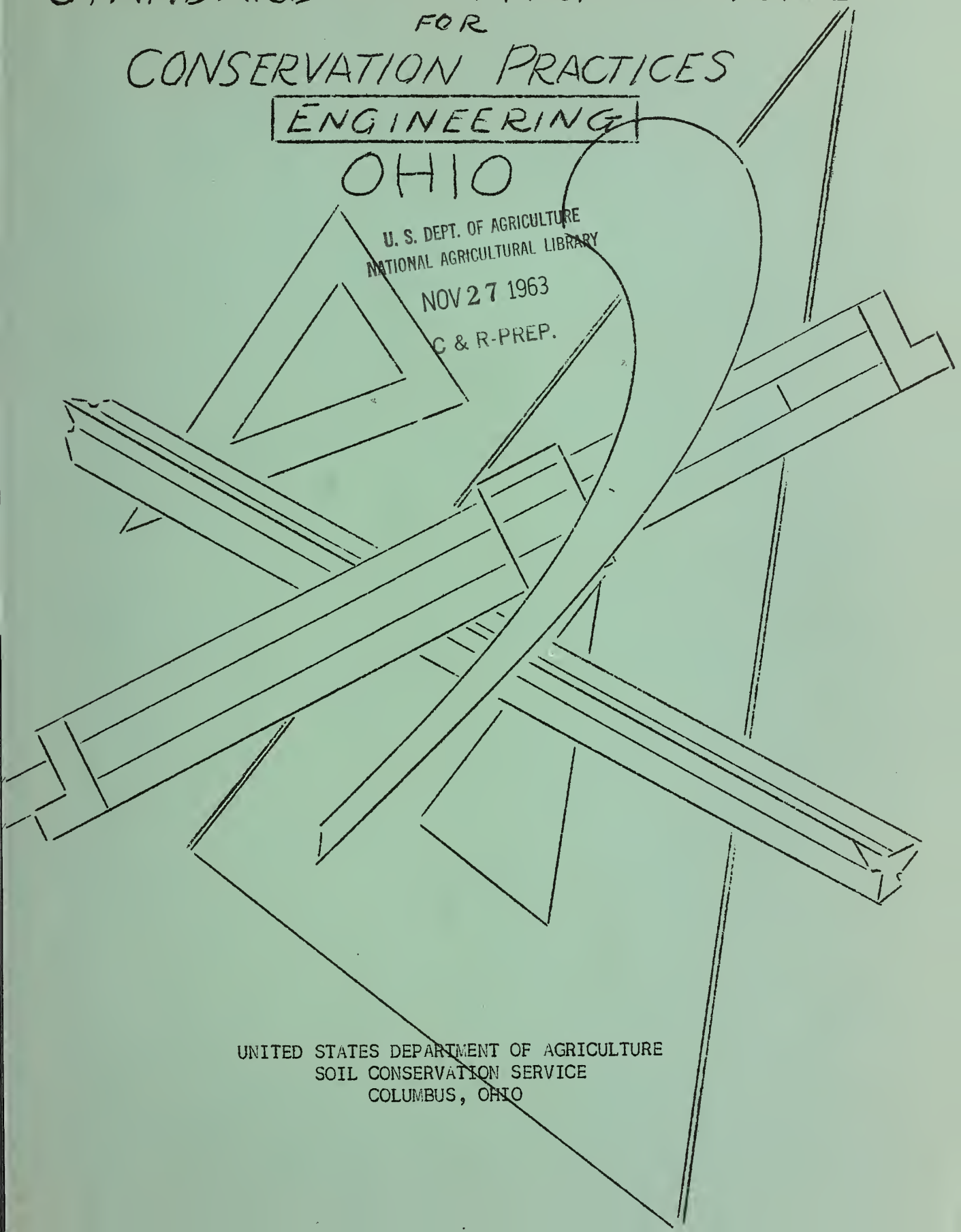
STANDARD AND SPECIFICATIONS FOR CONSERVATION PRACTICES

ENGINEERING

OHIO



UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
COLUMBUS, OHIO

58626

OHIO

ENGINEERING

STANDARD AND SPECIFICATIONS

For

CONSERVATION PRACTICES

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OHIO TECHNICAL STANDARD AND SPECIFICATIONS

For

BEDDING

1. Definition

Plowing, blading, or otherwise elevating the surface of flat land into a series of broad, low ridges separated by shallow, parallel dead furrows. (Ditches installed between beds in this practice will not be classed as Drainage Field Ditches.)

2. Purpose

To provide for the disposal of excess surface water on slowly permeable surface soils.

3. Conditions Where Practice Applies

a. This practice applies to slowly permeable soils having land slopes of 0 to 1% where tile drainage is not feasible.

b. Special equipment for land smoothing is not readily available.

c. Farm equipment commonly used by the farm operator can be used efficiently either parallel or across the beds.

d. Farm operator is familiar with the maintenance requirements of bedding systems.

4. Design Criteria

a. Direction

Beds shall be laid out with the dead furrows approximately parallel to the direction of greatest slope.

b. Width

The width of beds (distance between dead furrows) must be varied with the permeability of the soil and slope of the land. Bed widths for row crops normally vary from approximately 30 feet on relatively flat, very slowly permeable soils to approximately 80 feet on 1% moderately, slowly permeable soils. This width may be increased for permanent pasture, hay and grain crops. Bed widths should be adjusted to conform to the width of crop rows and farm machinery commonly used by the landowner.

c. Depth

A fall of at least 0.75 foot shall be provided from the center (crown) of the bed to the bottom of the dead furrow.

d. Drainage Outlets

Drainage field ditches shall be considered, and if needed, shall be included in the plans for improvement.

5. Specifications Guide

a. All trees, brush, stones or other objectionalbe material shall be disposed of so that they will not interfere with the construction, operation or maintenance of the bedding system.

b. All earth moved in the process of establishing the beds and dead furrows shall be spread or disposed of so it will not impede drainage from the crown of the bed to the dead furrow and to the drainage field ditch or other outlet.

c. Minor deviations in grade, not significantly affecting the functioning of the system, may be permitted.

6. Working Tools

a. Surface Drainage System (Bedding) J.S. 2

b. Figure 11.9, pages 11-32, Engineering Handbook for Soil Conservationists.

7. References

Engineering Handbook for Soil Conservationists, Part 11, pages 31-35.

Soil Conservation Service, Columbus, Ohio, July 1963

OHIO TECHNICAL STANDARD AND SPECIFICATIONS

for

DIKES AND LEVEES (Classes II and III)

1. Definition

An embankment of earth or other suitable materials to protect land against overflow from streams, lakes, and tidal influences; also to protect flat land areas from diffused surface waters.

2. Scope

This standard covers minimum quality requirements for planning, designing, and constructing Class II and Class III dikes and levees.1/ Dikes and levees will be referred to as "dikes" in this Standard. This standard includes all dikes falling within the class requirements installed with Soil Conservation Service assistance to provide protection for land and property and include dikes for floodways and wildlife improvement.

Class II dikes include embankments built to protect agricultural lands of medium to high capability with improvements generally limited to farmsteads and allied farm facilities. These dikes are installed to provide protection against floods of infrequent occurrence as covered in these standards.

Class III dikes are embankments which protect agricultural lands of relatively low capability or improvements of low value. These dikes are limited to low heads of water.

3. Purpose

The purposes of dikes are to improve land for crop production by prevention of overflow, improve drainage, protect property, and facilitate water level control on marshes and marsh developments in connection with Wildlife Wetland Developments.

1/ This standard does not include Class I dikes which will be designed to provide maximum feasible protection. Class I dikes include all dikes where one or more of the following conditions apply: (a) where there is a possibility of loss of life, (b) very high value land and improvements to be protected, (c) unusual site conditions, and (d) where dike is designed to withstand more than 12 feet of water above normal ground surface exclusive of crossings of sloughs, old channels or low areas. Class I dikes are designed in accordance with the criteria established for earth embankments, including foundation.

4. Class II Dikes

a. Conditions Where Practice Applies

(1) The land to be protected must be suitable for the intended use. Locations shall be such that practical and economical construction, accessibility and maintenance can be obtained. Property lines, soils, open water, watershed characteristics, runoff, and adequate outlets for either gravity or pump drainage must be favorable. Ohio drainage and water laws shall be adhered to in the planning of dikes.

(2) Mineral soils which are stable in dike embankment shall be available for construction. The use of organic soils in Class II dikes is not permissible.

(3) The maximum design water stage permitted this class dikes shall be 12 feet above normal ground level exclusive of crossings at channels, sloughs, and gullies.

b. Design Criteria

(1) The design and installation shall be based on engineering surveys and investigations which shall be made as provided for in applicable sections of the National Engineering Handbook. The stage and duration of high water for which protection is to be provided shall be determined from these investigations. Dikes of this class, including those dikes which are part of a floodway, shall, where feasible, provide protection for at least a 4 per cent chance flood. (25 year frequency)

(2) Height

The design height of the earth dike shall be equal to the sum of the requirements for design depth of water, allowance for wave height, freeboard, and settlement. Estimates of wave heights are to be based on local experience, or on hydraulic studies.

The minimum freeboard shall be 2 feet, or 1 foot plus the allowance for wave height, whichever is the greater.

The allowance for settlement shall be based on consideration of the properties of the soil material and the anticipated compaction, but shall be no less than 5 percent of the design height.

(3) Cross Section

The minimum requirements for the cross section of the dike, where fill is compacted by hauling and spreading equipment shall be as follows:

Design Water Height	Minimum Top Width	Steepest Side Slope
Feet	Feet	
0 - 6	6	$1\frac{1}{2}$:1
6 - 12	8	2:1

Where soils or water conditions make it impractical to construct the dike with hauling and spreading equipment, dumped fill may be used and shall have minimum cross section dimensions as follows:

Design Water Height	Minimum Top Width	Steepest Side Slope
Feet	Feet	
0 - 6	6	2:1
6 - 12	8	$2\frac{1}{2}$:1

Side slopes of 3:1 on water side and 2:1 on land side may be used instead of $2\frac{1}{2}$:1 for both slopes.

The top width should not be less than 10 feet where a maintenance road is planned on top of the dike. "Turn arounds" or passing areas should be provided as required on long dikes. Where the top width is greater than the minimum, the bottom width of the dike need not be increased above the minimum required, even though the side slopes are steeper than for the standards given above. However, the side slopes shall, in judgment of the responsible technician, be stable in all cases.

The side slopes shall be 3:1, or flatter, on the water side where severe wave action is expected, or where a steeper slope would be unstable under rapid drawdown conditions. Side slopes shall be 3:1, or flatter, on both sides where permeable soils of low plasticity, such as silty sands, inorganic silts, very fine sands, silty or clayey fine sands, etc. are used in construction.

A berm shall be placed to reinforce the land side toe where a dike crosses an old channel or where excessively porous fill or poor foundation conditions justify such reinforcement. Such berms shall be used if, during construction, the channel crossing is under water or saturated.

The standard design shall include a top width of the berm equal to, or greater than, the fill height of the dike above the top of the berm. The berm top shall be finished to an elevation not less than a foot above normal ground level and it shall be sloped towards the land side for drainage. The land side slope of the berm shall be not steeper than the landside slope of the dike.

An alternate design of the berm may be used where design is based on detailed site investigations, laboratory analyses, and adequate compaction is obtained.

(4) Ditches and Borrow Pits

Minimum berm widths between the toe of the dike and the edge of the excavated channel or borrow, shall be:

Fill Height	Minimum Berm Width
Under 6 feet	10 feet
Above 6 feet	15 feet

A land side ditch or borrow pit shall be far enough away from the dike so that a line drawn between (1) the point of intersection of the design water line with the water side of the dike, and (2) land side toe of the dike at the ground line, shall not intersect its cross section.

(5) Pipes and Conduits

The dike shall be protected from scour at a pump discharge or intake. A pump discharge pipe shall be installed above design high water or equipped with anti-seep collars. Structural measures shall be provided, where required, to protect against scour at the suction intake.

All conduits through the dike below the design high water line shall be equipped with anti-seep collars designed to increase the distance of the seepage line along the conduit by at least 15 per cent. Discharge conduits of pumps which are placed through a dike shall be equipped with a Dayton, or similar, coupling to prevent vibrations of the pumping plant being transmitted to the discharge conduit.

(6) Core Trench

A foundation cutoff, or core trench, shall be installed where there are layers of permeable soils which may permit excess seepage and/or create a piping hazard through the foundation at a depth less than three-fourths the height of the dike below natural ground level. The cutoff trench shall be of sufficient depth and width and filled with suitable soil to minimize such hazard.

(7) Drains

Toe drains shall be used where necessary to insure safety of dikes. Toe drains, where used, shall be located on the land side, have a graded sand-gravel filter and be designed and installed in accordance with SCS standards for such drains.

Field tile drains shall not be installed or permitted to remain without protection, closer to the land side toe of a dike than a distance three times design water height for the dike. If field tile drains are to be installed or remain closer than distance stated above, they shall be protected by a graded sand-gravel filter, as for a toe drain, or closed pipe laid within the specified distances from the dike may be used for such lines.

(8) Vegetative Cover and Riprap

An adequate protective cover of grasses shall be established on all exposed surfaces of the dike where, in the judgment of the responsible technician, this is necessary to protect against erosion. The dike will be fenced where necessary to provide protection for the vegetation and for controlled grazing.

The seedbed preparation, seeding, fertilizing, mulching and fencing shall comply with element standard

Riprap shall be used and placed according to SCS standards where required to control erosive velocities and protect against erosion from wave action. See element standard

5. Specifications Guide

Specifications will be in keeping with the preceding standard, will describe the essential requirements for proper installation of the dike and will include consideration of the following items:

a. Foundation Preparation

The foundation area shall be cleared of all trees, stumps, roots, brush, boulders, sod and debris. All channel banks and sharp breaks shall be sloped no steeper than 1:1. Topsoil which is high in organic matter shall be removed. The surface of the foundation area will be thoroughly scarified before placement of the embankment material.

The cutoff trench, where used, shall be excavated to lines and grades as shown on the plans. It shall be backfilled with suitable material available on the site in a manner as specified for earth embankment. The necessary degree of compaction shall be obtained by using equipment adapted to site conditions. The trench should, if feasible, be kept free of standing water during backfill operations. The material from cutoff trench may be placed in the landside toe of the dike.

b. Conduit Installation

All conduits through a dike shall be placed on a firm foundation to the lines and grades shown on the plans. Selected backfill material shall be placed in layers around the conduits and their component parts and each successive layer shall be thoroughly compacted.

c. Embankment Construction

The embankment material may be obtained from a selected borrow area, or from a channel. In the construction of borrow trenches on the water side of the dike, an unexcavated plug at least 25 feet wide shall be left at intervals not to exceed 1320 ft.

The fill material shall be free of organic matter and other objectionable material. Placing and spreading of fill by hauling equipment shall begin on the lowest part of the working area and continue in horizontal layers of approximate uniform thickness, preferably 6-inches thick, but not more than 18-inches thick, depending on the equipment used. Where borrow yields materials of varying texture and gradation, the more impervious material shall be placed toward the water side of the dike. The construction equipment shall be operated over the area of each layer in a manner to break up large clods, and obtain compaction.

Water shall be added to the fill material where it is too dry to permit compaction. Fill material shall be moist, but not too wet for equipment operations and shaping.

Dumped fill, where used, shall be placed in layers or deposited in a manner suitable to the equipment used and the material excavated. Shaping shall be done so as to break up lumps and clods of earth. Excessively wet material shall be placed to permit free drainage and shaped after it has drained. When the fill slumps due to wetness, the dike shall be constructed in stages.

6. Class III Dikes

a. Conditions Where Practice Applies

(1) Class III dikes are usually built where the spoil from excavated drainage channels is available. The land to be protected must be suitable for the intended agricultural use. Class III dikes are to be used only on sites where:

(a) The maximum design water stage 2/ against the dike is:

1. 6 feet for mineral soils

2. 4 feet for organic soils

(2) Damages which are likely to occur from a dike failure are low.

2/ The maximum design water stage is the water elevation of the flood selected for design minus the elevation of the normal ground surface at the dike, excluding consideration of channels, sloughs, swales and gullies.

b. Design Criteria

The design criteria shall be based on site conditions as determined from engineering surveys and investigations. The minimum specifications for for top width, side slopes, freeboard, and berm width are listed below:

	Top width	Steepest slope	Freeboard	Berm Width
Mineral Soils	4'	1½ to 1	1'	6'
Organic Soils	6'	1 to 1	1'	6'

The berm widths shall be adequate to prevent undermining the dike.

Dikes constructed from channel spoil may be shaped to approximate cross section. However, the spoil must be of required height and left so that sloughing and sliding will not impair the design section.

Dikes of organic soils shall be installed in accordance with the principles given in Chapter 11, Section 16, National Engineering Handbook.

7. Specifications Guide

Specifications shall be in keeping with the preceding standard. They shall provide that the site be cleared of trees, brush, other vegetation, and debris. Trees and stumps shall be cut at approximate ground level. The surface shall be scarified.

The spoil shall be placed to the height required for the dike and where needed to obtain stability or adequate compaction it shall be raised in stages.

Earth fill around conduits through the dike shall be thoroughly tamped.

Soil Conservation Service, Columbus, Ohio - July 1963

OHIO TECHNICAL STANDARD AND SPECIFICATIONS

For

DIVERSION

1. Definition

A channel with a supporting ridge on the lower side constructed across the slope.

2. Purpose

The purpose of this practice is to divert water from areas where it is in excess to sites where it can be used or disposed of safely.

3. Conditions Where Practice Applies

This practice applies to sites where:

a. Runoff from higher lying areas is damaging cropland, pasture land, farmsteads, or conservation practices such as terraces or strip cropping.

b. Surface and shallow subsurface flow is damaging sloping upland.

c. Runoff is available for diversion and use on nearby sites.

Diversions are not applicable below high sediment producing areas unless land treatment practices or structural measures, designed to prevent damaging accumulations of sediment in the channels are installed with or before the diversions.

4. Design Criteria

a. Capacity

Diversions protecting agricultural land must have capacity to carry the peak runoff from a 10-year-frequency storm as a minimum, with a freeboard not less than 0.3 foot. Diversions designed to protect buildings and roads, and those designed to function in connection with other structures, shall have enough capacity to carry the peak runoff expected from a storm frequency consistent with the hazard involved.

Ten-year frequency runoff may be determined from Drawing No. 3-L-14054 or other approved methods.

b. Velocities

Diversions and outlets should be designed to keep velocities as high as will be safe for the channel conditions expected to prevent sedimentation.

Maximum allowable velocities for expected channel conditions to prevent erosion:

Bare Channels:

Sand - 1.5 feet per second
Other - 2.0 feet per second

Vegetated Channels:

Chart 3-L-45288, "Design Velocities for Vegetated Channels" will be used to determine allowable velocities for varrying conditions of cover. Use velocities exceeding 5 feet per second only where good covers and proper maintenance can be obtained. Values of "n" will be based on recommendations as given in SCS-TP-61 (Handbook of Channel Design for Soil and Water Conservation - Revised June 1954).

c. Cross Section

The channel may be parabolic, V-shaped, or trapezoidal. The diversion shall be designed to have stable side slopes. The ridge height shall include a 20% settlement factor. The diversions ridge shall have a minimum top width of 4 feet at the design elevation, or 2 feet at the top of the constructed diversion.

d. Location

Diversion location shall be determined by outlet conditions, topography, land use, cultural operations, soil type, and length of slope.

A diversion in a cultivated field must be aligned or provided with a grassed correction strip so as to permit the use of modern farming equipment.

e. Protection Against Sedimentation

When movement of sediment into the channel is a significant problem, a vegetated filter strip or grassed waterways shall be used.

f. Outlets

Each diversion must have an adequate outlet. The outlet may be a natural grassed waterway, vegetated area, grade stabilization structure, or stable watercourse. In all cases, the outlet must convey runoff to a point where outflow will not cause damage. Vegetative outlets shall be installed before diversion construction, if needed, to insure, establishment of vegetative cover in the outlet channel.

The design elevation of the water surface in the diversion shall not be lower than the design elevation of the water surface in the outlet at their junction when both are operating at design flow.

5. Specifications Guide

Specifications shall be in keeping with the preceding standard, shall describe the requirements for proper installation of the practice to achieve its intended purpose, and shall include consideration of the following items:

All dead furrows, ditches, or gullies to be crossed shall be filled before construction begins or as a part of construction. All old terraces, fence rows, or other obstructions that will interfere with the successful operation of the diversion shall be removed.

The minimum cross section shall meet the specified dimensions.

The top of the constructed ridge shall not be lower at any point than the design elevation plus the specified over-fill for settlement and a minimum of 0.3 foot freeboard. Where vegetation is required because of channel velocity, make seeding in accordance with Ohio Agronomy Standard on Grassed Waterway or Outlet, IV-A-19a. Ohio drainage and water laws shall be adhered to in the location of diversions and outlets.

6. Working Tools

a. Runoff Chart, pp 301 and 302, Ready Reference.

b. Runoff Chart, Part 3, pp 2 and 3, Engineering Handbook for Soil Conservationists.

c. Design Chart, pp 331 and 332, Ready Reference.

d. Design Chart, Part 9, p. 3, Engineering Handbook for Soil Conservationists.

e. Construction Charts, Part 8, pp 6 to 8, Engineering Handbook for Soil Conservationists.

f. Construction Charts, pp 346 through 352, Ready Reference.

g. Diversion Construction, by Bulldozer, J. S. 42.

h. One Way Method Terrace Construction, J. S. 23.

i. Two Way Method Terrace Construction, J. S. 24.

j. Handbook of Channel Design for Soil and Water Conservation, SCS-TP-61, revised June 1954.

7. References

a. Engineering Handbook for Soil Conservationists, Part 9.

b. Ready Reference, pp 301, 302, 331 and 332.

c. Instructions for Determining Cropping Systems for Sloping Land, Ohio Technical Guide Book, Sec. III-B-5.

OHIO TECHNICAL STANDARD AND SPECIFICATIONS

For

DRAINAGE FIELD DITCH (FIELD DRAINS)

1. Definition

   a. A shallow graded ditch for collecting water within a field, usually constructed with flat side slopes for ease of crossing. (This does not include Drainage Main or Lateral, or grassed waterway or outlet.) (Includes single, parallel, "W" and cross slope ditches.)

2. Purpose

   Drainage field ditches are installed to:

   a. Intercept excess runoff such as sheet flow from land surfaces.

   b. Collect runoff from bedding system furrows, plow furrows, or crop row furrows.

   c. Drain depressional areas.

3. Conditions Where Practice Applies

   a. Applicable sites are flat or nearly flat lands (usually less than 1%) that:

      (1) Have a length of land slope or length of row too long for ready movement of runoff across the surface.

      (2) Have soils of low permeability or shallowness over barriers, such as rock or clay, which hold or prevent ready percolation of water to a deep stratum.

      (3) Have surface depressions or barriers which trap rainfall.

      (4) Are wet as a result of runoff from uplands.

      (5) Have adequate outlets available for disposal of drainage water by gravity flow or by means of dikes and pumping. The outlet shall be adequate for the quantity and quality of effluent to be disposed of with consideration of possible damages above or below the point of discharge. Ohio drainage and water laws shall be adhered to in the planning and installation of drainage field ditches.

4. Design Criteria

   a. Capacity - Use "C" curve on the Soil Conservation Service Drawing 3-L-14657. Modification of this criteria should be made (higher C.F.S.) where (1) high value crops are to be grown or (2) degree of slope of land is such that overtopping may create a significant problem.

The minimum cross sectional area for each ditch shall be 5 square feet and the minimum depth shall be 9 inches. Exceptions may be made to this specification if the length of ditch involved and the area affected is considered insignificant to the total job.

b. Side Slopes

Side slopes shall be 8:1 or flatter where farm operations are across the ditch. They shall be 4:1 or flatter where operations are parallel to the ditch. When the ditch area is not to be farmed provide stable side slopes based on soil characteristics (usually 2:1) .

c. Spacing and Location

The distance between ditches of a "w" ditch should normally be about 75 feet. See element standard specifications "Depth and Spacing of the tile and spacing of drainage field ditches" or the Ohio Drainage Guide for spacing and location of drainage field ditches. Where ditches are located at the ends of fields in connection with bedding systems, a turn strip at least 30 feet wide should be provided between the ditch and field boundary.

d. Spoilbanks

(1) Where depressional areas occur between ditches, the excavated materials should be placed and spread in such depressions.

(2) Spoilbanks will be placed in a manner to permit operation of farming equipment and free entry of water from adjacent land surfaces.

e. Appurtenances

(1) Seeding or sodding of certain areas and/or structures will be provided when necessary to conduct flow without excessive erosion.

5. Specifications Guide

Specifications will be in keeping with the preceding standard, will describe the requirements for proper installation of the practice to achieve its intended purpose and will include consideration of the following items:

a. Areas to be excavated and areas to be occupied by spoil shall be cleared of trees, brush and other debris as required for construction and maintenance.

b. Ditches shall be constructed to a continuous bottom grade toward the outlet. Finished sections will be uniform and smooth.

c. Minor deviations in finished grade which do not affect the functioning of the ditch may be permitted.

6. Working Tools

a. Drainage Runoff Curves for Open Ditch Design, page 16, Engineering Handbook for Soil Conservationists and pages 3 and 4, Ohio Drainage Guide.

b. Open Ditch Design Charts, pages 21-23a, Engineering Handbook for Soil Conservationists.

c. Ditch Design Tables, pages 5-10, Ohio Drainage Guide.

d. Graphic Solution of Drainage Channel Dimensions, Drawing No. 5-L-7214 (6 sheets).

e. Random Ditch System of Surface Drainage, J.S. 3.

f. Cross Slope System, J.S. 4.

g. Parallel Ditch System of Surface Drainage, J.S. 5.

h. Field Ditch System, J.S. 6.

i. Constructing Double Channel Ditch or Twin Waterway, J.S. 25.

j. Plow construction of a Shallow Surface Drainage Control, J.S. 41.

7. References

a. Ohio Drainage Guide.

b. Engineering Handbook for Soil Conservationists, Part II.

c. Ready Reference.

d. Surface Drainage of Flat Land, Extension Bulletin, No. 299, June 1948.

Soil Conservation Service, Columbus, Ohio, July 1963

OHIO TECHNICAL STANDARD AND SPECIFICATIONS

For

DRAINAGE MAIN OR LATERAL

1. Definition

An open drainage ditch constructed to a designed size and grade. (Does not include Drainage Field Ditch.)

2. Scope

This standard covers open ditches for disposal of surface and subsurface drainage waters primarily collected by drainage field ditches and tile lines. It also covers the minimum drainage requirements for multipurpose channels which provide drainage outlets for agricultural lands.

3. Purpose

The purpose of a drainage main or lateral is to dispose of excess surface or subsurface water, intercept ground water, or to control ground water levels or a combination of these objectives.

4. Conditions Where Practice Applies

All lands to be drained shall be suitable for agricultural use within their land capabilities after installation of required drainage and other conservation practices.

An outlet for the open drainage system shall be available, either by gravity flow or by pumping. The outlet shall provide for the quantity and quality of water to be disposed of, with consideration of possible damages above or below the point of discharge. Ohio drainage and water laws shall be adhered to in the planning and installation of Drainage Mains or Laterals.

5. Design Criteria

a. Capacity of Mains or Laterals

(1) Where general field crops are to be produced in a drainage area of two square miles or greater, and with an average slope of less than 25 feet per mile, use "C" curve from drawing ES-701 (Sutton's drainage curves). For drainage areas less than two square miles, use the "C" curve on the Soil Conservation Service Drawing #3-L-14657.

Modification of the above specifications may be made where:

(a) High value crops are to be grown and a greater degree of protection is desired.

(b) The crop grown or the management system used does not require such a high protection.

(c) The watershed has a greater general slope than 25 feet per mile. In these cases higher capacities than are indicated above will be required. As a rule of thumb, the next higher curve can be used. For example, if "C" curve drainage is desired in "hill land," read the value given by the "B" curve.

(d) "C" curve protection is attainable only by major improvements such as large channels or replacement of large culverts and bridges. "D" curve drainage shall be the minimum in these cases.

b. Hydraulic Gradient

The design hydraulic gradient for drainage ditches shall be determined from control points including elevations of significant low areas served by the ditch and hydraulic gradients of any tributary ditches and the outlet. Where control point elevations are estimated rather than computed from survey data, the hydraulic gradient shall be no less than: 1 foot below fields which will receive normal drainage from open ditches draining more than 1 square mile; 0.5 foot for ditches draining 40 acres to 640 acres; and 0.3 foot for ditches draining less than 40 acres. For lands to be used only for the more water tolerant crops such as trees and grasses, these requirements may be modified and the hydraulic gradient set at ground level. These provisions do not apply to channels where flow is contained by levees or dikes.

The effects of hydraulic losses caused by culverts, bridges, or other obstructions in the channel section shall be considered.

c. Velocity (Permissible)

Water shall be conveyed at non-erosive velocities to an adequate outlet. The following velocity table shall be used as a guide in determining maximum allowable velocities in ditches (bankful stage or 10-year frequency stage if less than bankful)

2-1/2 feet per second in sand and sandy loam (non-colloidal)
3 feet per second in silt loam
3-1/2 feet per second in sandy clay loam
4 feet per second in clay loam
5 feet per second in stiff clay, fine gravel and graded loam to cobbles
5-1/2 feet per second in graded silt to cobbles (colloidal)
6 feet per second in shale, hardpan and coarse gravel

d. Channel Depth

The channel depth shall provide a grade low enough to drain all lands that can be economically served by the outlet channel. The minimum depth for channels serving as outlets to tile should be determined by the tile mains draining into it. The tile drain invert shall be at least 1 foot above normal growing season water level in the ditch, except where lower values are specified for a job because of unusual site conditions.

e. Side Slopes

Mininum side slopes for channels are as follows for ordinary conditions:

Subsoil Texture	Side Slopes
Fine (Clay and Clay Loam)	1.5:1
Medium (Loam and Silt Loam)	2:1

Side slopes of Peat, Muck and Sand shall be 1:1

f. Bottom Widths

The minimum bottom width for ditches in mineral soils shall be four feet, except where lower values are specified for a job because of the availability of special equipment, unusual conditions, or special techniques for performing the work.

In sandy and muck soils, the minimum bottom width should be 6 feet.

g. Alignment

The best practical alignment shall be secured. Circular Curves with as long as possible radii should be used. The following table gives a recommendation which should be followed as closely as possible.

RECOMMENDED MINIMUM RADIUS OF CURVATURE WITHOUT BANK PROTECTION

Kind of Ditches	Fall per mile	Minimum radius of curvature	Approximate degree of curve
Small ditches - Max. top width 15 feet	Under 3 ft.	300	19°
	3 ft. to 6 ft.	400	14°
Medium-sized ditch top width 15 to 35'	Under 3 ft.	500	11°
	3 ft. to 6 ft.	600	10°
Large ditches (over 35 ft. top width)	Under 3 ft.	600	10°
	3 ft. to 6 ft.	800	7°

Problems outside the range given above and problems in erosive soils call for special consideration. With bank protection, the minimum radius should be 100 feet.

h. Berms and Spoilbanks

(1) Adequate berms shall be considered for the following purposes:

(a) Lessen sloughing of ditchbanks caused by heavy bank loads too near the edge of ditchbanks.

(b) Prevent excavated material from washing or rolling back into ditches.

(c) Provide for work areas and facilitate spoil bank spreading.

(d) Eliminate the need for moving spoil banks in future operations.

(e) Provide roadways for maintenance equipment.

The following minimum berm widths should be used:

Ditch depths Feet	Minimum berms Feet
2 - 4	4.0
4 - 10	10.0

Where soils are unstable substantially wider berms are needed.

(2) Excavated material shall be deposited and spread along one or both sides of the ditch, except where used for levees, timber or brush cover or other special use. Slope of the spoil after spreading should be at least 3:1 on the channel side and at least 4:1 on the field side. Openings shall be provided for surface water to enter the ditch.

i. Roughness Coefficient

Unless special site studies are available to justify other values, the following table shall govern the selection of the value of "n" in the Manning's formula.

Hydraulic Radius	n
Less than 2.5	0.040 - 0.045
2.5 - 4.0	0.035 - 0.040
4.0 - 5.0	0.030 - 0.035
Over 5.0	0.025 - 0.030

j. Related Structures and Ditch Protection

Mains or laterals shall be protected against erosion by chutes, drop structures, pipe drops, other suitable structures or grassed waterway or specially graded channel entrances where surface water or shallow ditches enter deeper ditches.

Grade control structures, bank protection, or other suitable measures shall be used where necessary to reduce velocities and control erosion.

Culverts and bridges shall have enough hydraulic capacity and depth for drainage needs and to minimize obstruction to flow.

Capacities of pipe or drop structures ordinarily will be determined by use of the applicable drainage coefficients with the "island" type of construction used to protect the structure from washout.

Each structure for an open ditch system shall be designed in accordance with Soil Conservation Service standards for the kind of structure and type of construction involved.

A strip of sod should be maintained along both banks of a ditch.

6. Specifications Guide

Specifications will be in keeping with the preceding standard, will describe the requirements for proper installation of the practice to achieve its intended purpose, and will include consideration of the following items:

The areas to be excavated or occupied by the berm or spoilbanks shall be cleared of trees, brush, and other debris. Cleared debris shall be disposed of by burning or as otherwise specified.

Excavation shall be made as indicated by slope and grade stakes and as provided in the job plans. The finished earth section shall be generally smooth and of good appearance.

Vegetation shall be established where specified in the plans.

7. Working Tools

a. Drainage Runoff Curves for Open Ditch Design 3-L-14657 or 3-L-26525.

b. Graphic Solution of Open Channels, Drawing 3-L-9192.

c. Open Outlet Ditch for Field Drainage J.S. 30.

d. It Pays to Maintain Your Ditches J.S. 31

8. References

a. National Engineering Handbook, Sec. 16, Chapter 6.

b. Engineering Handbook for Soil Conservationists, Part II, P 11-9 to 11-27.

c. Ready Reference P 374-376, 383, 384-387

d. Ohio Drainage Guide

e. E&WP Unit Memo - Hydrology No. 1, Photos of Manning's Roughness Factor "n".

f. Farm Drainage, USDA Farmers Bulletin No. 2046.

g. Maintaining Drainage Systems, USDA Farmers Bulletin 2047.

Soil Conservation Service, Columbus, Ohio, July 1963

OHIO TECHNICAL STANDARD AND SPECIFICATIONS

For

FARM POND

A. GENERAL

1. Definition

A water impoundment made by constructing a dam or embankment, or by excavating a pit or "dugout." (Such ponds do not include Spring Development or Irrigation Reservoirs.)

Ponds constructed by the first of these methods are referred to hereinafter as "Embankment Ponds" and those constructed by the latter method as "Excavated Ponds." Ponds resulting from both excavation and embankment are classified as Embankment Ponds where the depth of water impounded against the embankment at spillway elevation is 3 feet or more.

2. Scope

This standard establishes the minimum acceptable quality for the design and construction of farm ponds located in predominantly rural or agricultural areas when:

a. Failure of the structure would not result in loss of life; in damage to homes, commercial or industrial buildings, main highways, or railroads; or in interruption of the use of service of public utilities; or

b. The product of the storage times the effective height of the dam does not exceed 3,000 where the storage is defined as the original volume (acre-feet) in the reservoir at the elevation of the crest of the emergency spillway and the effective height of the dam is defined as the difference in elevation (feet) between the emergency spillway crest and the lowest point in the cross section taken along the centerline of the dam; or

c. The vertical distance between the lowest point along the centerline of the dam and the crest of the emergency spillway does not exceed 20 feet.

Note: Emergency Spillway is defined as a vegetated opening or channel providing for the passage of emergency flows beyond a point hazardous to a structure. It operates only when the inflow exceeds the design capacity of the principal spillway or, on occasions where principal spillway is not functioning properly. Where vegetated spillways is the only spillway provided, it carries both the principal and the emergency design flows.

Auxiliary Spillway is defined as a vegetated channel spillway carrying a flow at safe velocities throughout its length to a stabilized grade. This flow is combined with the flow of the principal spillway to handle the design inflow normally taken by the principal spillway. (The principal spillway is thus reduced in size.) The auxiliary spillway usually will operate more frequently than an emergency spillway.

3. Purpose

Farm ponds are constructed to provide for beneficial uses of water on the farm such as water for livestock, crop spraying, fire protection, wildlife area improvements, and recreation.

4. Conditions where practice applies

a. General

This practice applies only where it is determined that additional water supply on the farm is justified.

b. Site Conditions

Site Conditions will meet the requirements shown in Table 1.

Table 1

Drainage Area Acres	Design Storm	Without Temporary Storage			With Temporary Storage		
		Pipe or Struc. Spwy.	Vegetated Spillway		Pipe or Struc. Spwy. & Temp. Storage	Vegetated Spillway	
			Aux. Spwy.	Emerg. Spwy. 3/		Aux. Spwy.	Emerg. Spwy. 3/
		Vol.	Vol.	Peak	Vol.	Vol.	Peak
		% of Design Storm 4/			% of Design Storm 4/		
					(Min.)	(Max.)	(Min.)
Over 250	Q-50	85 100	15	50 50	85 100	15	50 50
31-250	Q-25	75 100	25	40 40	75 100	25	40 40
10-30 1/	Q-5	Design in accordance with Engineering Handbook for Soil Conservationists - Part 4		100%-10 yr.			100%-10 yr.
Less than 10 ac. 2/	Q-5	100% Vegetated Spillway					

1/ Includes drainage areas less than 10 acres where pipe spillway is required.

2/ Where pipe spillway is not required. (See Table 2)

3/ Emergency or principal vegetative spillway capacity may be increased.

4/ Use USWP TP-40. Also use either Watershed Characteristics (Sigma W) or National Engineering Handbook, Hydrology Section

c. Drainage Area

The contributing watershed shall be protected by conservation practices deemed adequate to control erosion and prevent excess sedimentation.

The ratio of the watershed area to the pond area at normal water level shall not be less than 6:1 excepting where auxiliary means of water supply are provided. The ratio shall not be greater than 40:1 for ponds with 30 acres or less of watershed.

Ponds shall be protected from contamination from barnyards, septic tanks, or other sources.

Precautions should be taken in the use of pond water where poisonous sprays are used in the watershed or spray equipment is refilled at the pond. Equipment used in the application of poisons should not be flushed out or washed at a wildlife, fish or stockwater pond.

d. Depth

The topography and soils of the site shall permit storage of water at a depth and volume which will insure a dependable supply, considering beneficial use, sedimentation, season of use, and evaporation and seepage losses.

At least 25 percent of the pond area at normal water level shall have a minimum depth of eight feet (minimum 6 feet for spring fed ponds) or at least 50 percent of the pond area shall have a minimum depth of six feet when underlying material (rock, gravel, etc.) prevents excavation.

e. Foundation

The area on which a dam is to be placed shall consist of material that has sufficient bearing strength to support the dam without excessive consolidation as may result on mucks or saturated silts. The foundation must consist of, or be underlain by, relatively impervious material which will prevent excess passage of water.

f. Reservoir Area

The minimum surface area of the pond at normal water level shall be twenty-five hundredths (0.25) acre for ponds to be used for fish production and fifteen hundredths (0.15) acre for other uses.

Where surface runoff is the primary source of water for a pond, the soils shall be impervious enough to prevent excessive seepage losses, or shall be of such nature that sealing is practicable.

B. EMBANKMENT PONDS

1. Design Criteria

a. Reservoir Area

Soil investigations shall be made in accordance with Engineering Memorandum SCS-33.

No fill material shall be excavated from the reservoir area within three feet of the subsurface layer of loose rock, rock ledge, sand or gravel strata, or any freely permeable soil layer unless sealing and/or lining measures are planned in which case sealing and/or lining measures needed will be made a part of the plans to assure the proper functioning of the pond.

b. Foundation Cutoff

A cutoff of relatively impervious material shall be provided under the dam. The cutoff shall extend along the centerline of the dam and its abutments as required and be deep enough to extend into a relatively impervious layer. It shall have a minimum depth of 3.0 feet.

The cutoff trench shall have a bottom width adequate to accommodate the equipment used for excavation, backfill, and compaction operations. Side slopes shall be no steeper than 1:1.

c. Earth Embankment

(1) Top Width * - The minimum top width of the dam shall be:

Height of Dam	Top Width
10 feet or less	6 feet
11 - 14 feet	8 feet
15 - 20 feet	9 feet
20 - 25 feet	10 feet

*Farm road crossing - minimum - 12 feet.

(2) Side Slopes - The combined upstream and downstream side slopes of the settled embankment shall not be numerically less than 5 horizontal to 1 vertical, with the downstream slope no steeper than 2:1 and upstream slope no steeper than 2.5:1.

(3) Berm - Upstream. A berm having a width of at least 5 feet shall be constructed across the earth fill at normal pool elevation on the upstream side and extending to the end abutments on all dams with a permanent pond area in excess of 2 acres. The berm shall be optional on ponds of 2 acres water surface or less.

A berm semi-circular in shape extending not less than 5 feet from the riser inlet shall be installed on all jobs to protect the riser from damage by ice or floating debris.

(4) Freeboard - The minimum elevation of the top of the settled embankment shall be 1 foot above the water surface in the reservoir with the emergency spillway flowing at design depth.

(5) Allowance for settlement - The design height of the dam shall be increased by the amount needed to insure that the design top elevation will be maintained after all settlement has taken place. This increase shall be not less than 5 percent.

d. Pipe Conduits (pipe spillways)

A pipe conduit, with needed appurtenances, shall be placed under or through the dam except where the rate and duration of flow can be handled safely by a vegetated earth spillway or a rock spillway is available. (Acts as emergency spillway also.) Table 2 shows spillway requirements (pipe conduit or bleeder drain).

Table 2

Drainage Area (Acres)	Continuous spring or seep flow feeding pond	Site conditions permit construction of a vegetative spillway meeting the permissible velocity limitation	Type of spillway required in addition to side spillway
Over 10 acres	Under any conditions ---------		Pipe
Less than 10 acres	Yes	No	Pipe
Less than 10 acres	Yes	Yes	Bleeder Drain
Less than 10 acres	No	Yes	None
Less than 10 acres	No	No	Bleeder Drain or pipe
Where drainage area is negligible (2 ac. or less) with springs or seeps the principal source of supply	Yes	No	Bleeder Drain

(1) Size - The capacity of the pipe conduit shall be adequate to discharge long-duration, continuous, or frequent flows without flow through the earth spillways. The minimum diameter of the pipe shall be 6" smooth or 8" corrugated or helical.

Where the pipe conduit diameter is 10 inches or greater, its design discharge may be considered in calculating the peak-outflow rate through the emergency spillway.

(2) Inlet - The crest elevation of the inlet or riser shall be at least 1.0 foot below the crest elevation of the earth spillway. Where the pipe conduit is designed as a principal spillway, the crest elevation of the inlet or riser shall be such that full flow will be generated in the barrel before there is discharge through the earth spillway.

The pipe conduit shall be provided with a standard riser or a hooded type inlet. The dimensions of either type must meet the design requirements for efficient hydraulic flow. Either type of inlet must be provided with an adequate baffle. (Bleeder drains are excluded from these requirements)

In the design of Hood Inlets, the minimum head over the pipe invert at inlet required for positive priming of the conduit is:

Smooth steel pipe (tight joints)	- 1.4D
Corrugated or Helical metal pipe	- 1.8D

Where D is the pipe diameter.

(3) Propped outlet - The fill shall be protected from damage by the pipe discharge. A standard propped outlet or S.A.F. outlet, shall be installed on all pipe conduits greater than 12-inches in diameter. For pipe conduits 12 inches and smaller, either a propped outlet or a 4-feet wide berm, in lieu of the prop, is satisfactory (See Dwgs. 3-N-45103, 3-N-45113, and 3-N-45399). When a propped outlet is used the pipe shall extend a minimum of 8 feet downstream beyond the prop.

A stilling basin of designed dimensions may be excavated at the time of installation.

(4) Pipe - The following pipes are acceptable: Cast-iron, wrought-iron, steel, corrugated or spiral metal, asbestos-cement, concrete, and rubber-gasket vitrified clay. All pipe joints shall be made watertight by the use of watertight couplings or gaskets or by welding or caulking. Asbestos-cement, concrete, and vitrified clay pipe shall be laid in a concrete bedding. All pipe shall be capable of withstanding the external loading.

(5) Corrugated iron or steel pipe - May be used in PL 46 and ACP operations with the following limitations:

(a) That the diameter of principal spillway barrels shall not exceed 42 inches.

(b) That the pipe shall be double riveted, asphalt coated, and have watertight connecting bands.

(c) That the minimum gage of the pipe shall be as shown in Table 3.

(d) The maximum height of fill over the pipe at the centerline of the dam shall be 25 feet.

Table 3

Corrugated iron or steel pipe gage for various fill heights
Reference: Federal Specifications QQc-806A

Height of Fill above Top of Pipe (Feet)	Diameter of Pipe in Inches									
	8	10	12	15	18	21	24	30	36	42
2 - 25	16	16	16	16	16	16	14	14	12	12

Note: For Class 2 corrugations - 2-2/3 inch pitch, 1/2 inch depth, annular corrugation.

(6) Corrugated or Spiral Aluminum Pipe - Corrugated or spiral aluminum pipe may be used in Public Law 46 and ACP operations and for Land Treatment Measures under paragraph 1111.11c of the Watershed Protection Handbook with the following limitations:

(a) That the diameter of principal spillway barrels shall not exceed 36 inches.

(b) That the maximum positive or negative pressure in the principal spillway barrel is limited to not more than 15 feet of water.

(c) That the pipe shall not be used in soils that have a pH value outside the range of 4 to 9 or in situations where a record of rapid corrosion of similar material is known to exist.

(d) That the minimum gage of the pipe and the maximum height of fill over the top of the pipe shall be as shown in Table 4.

Table 4

Corrugated or Spiral Aluminum Pipe Gage for Various Fill Heights

Height of fill above top of pipe (feet)	Diameter of Pipe in Inches								
	8	10	12	15	18	21	24	30	36
2 - 10	16	16	16	16	16	16	16	14	14
11 - 20	16	16	16	16	16	16	14	14	12
21 - 25	16	16	16	16	14	14	12	12	10

(7) Anti-seep Collars - Anti-seep collars shall be installed around the pipe conduit within the normal saturation zone. Sufficient anti-seep collars shall be used to increase the creepline through the normal saturation area along the conduit by a minimum of 15%.

The anti-seep collars and their connections to the pipe shall be watertight. The maximum spacing shall be approximately 14 times the minimum projection of the collar measured perpendicular to the pipe.

(8) Bleeder Drains - The bleeder drain is installed to provide protection to vegetative spillways from damage caused by continuous, or frequent, flows of water from springs or seeps.

The bleeder drain should be located in the abutment of the site at the end of the fill opposite to that where the principal vegetative spillway is located. It shall not be placed under the vegetative spillway. The inlet end shall be located a minimum of 0.25 foot below the crest of the vegetative spillway and the outlet end shall discharge its flow a minimum of 1.0 foot above stream bottom or low ground below the fill, far enough downstream to prevent damage to the fill.

The bleeder drain may be constructed of drain tile, vitrified sewer pipe, plastic pipe, cement-asbestos pipe or other tile or pipe of equal or better quality.

The minimum permissible diameter of tile or pipe is 4 inches.

The minimum depth of trench for the bleeder drain shall be 30 inches.

When tile or jointed pipe is used, a section of continuous rigid pipe, a minimum length of 8 feet, shall be installed on the inlet end of the drain; another similar length shall be installed on the outlet end.

Protection shall be provided for exclusion of animals at both the inlet and outlet ends of the drain.

(9) Trash guards - Where necessary to prevent clogging of the conduit, an approved type of trash guard shall be installed at the inlet or riser. Fences or other devices, designed to prevent humans or livestock from injury because of open inlets, will be installed where needed and shown on the plans.

(10) Drain pipe - A drain pipe with a suitable valve shall be provided where needed for proper pond management. The pipe conduit may be used as a drain when so located as to accomplish this function.

(11) Water supply pipes - Supply pipes to watering troughs and other appurtenances shall have a minimum inside diameter of 1-1/4 inches for galvanized iron or steel; or 1-inch for non-corrosive tubing. A minimum of two anti-seep collars of at least 24-inch diameter shall be firmly attached to the pipeline when pipe is placed under or through the fill. Valves shall be protected from frost damage and installed so that they are accessible from the surface of the fill or ground by means of an open stack or well.

(12) Water supply pipe intake - A suitable water supply intake shall be provided. A surface type intake that removes water 18 inches to 3 feet below the surface should be provided where pond water will be used inside buildings, for domestic use, or where water with high color, odor and turbidity would be undesirable. A screen should be provided on the inlet. An intake near the bottom of the pond may be used for livestock water and for uses not mentioned above.

e. Earth Spillways

(1) Capacity. Refer to Table 1. Emergency spillways shall be designed for safe velocities through the control section and a reasonable distance below.

Maximum permissible velocities

Auxiliary	Principal	Quality of vegetative cover expected
4.0'/sec.	3.0'/sec.	Only sparse cover can be expected
5.0'/sec.	4.0'/sec.	To be used under normal conditions
6.0'/sec.	5.0'/sec.	Only where vigorous sod can be obtained

The maximum design flow depth over the crest of a principal vegetative spillway shall be 12 inches.

(2) Cross Section - Constructed earth spillways shall be trapezoidal and will be located in undisturbed or compacted earth. The side slopes shall be stable for the material in which the spillway is to be constructed. Side slopes shall be no steeper than 3:1.

(3) Component Parts - Constructed spillways shall have an inlet channel and an exit channel.

Upstream from the control section the inlet channel shall be level for the distance needed to protect and maintain the crest elevation of the spillway (minimum of 20 feet). The inlet channel may be curved to fit existing topography.

The grade of the exit channel of a constructed spillway shall fall within the range established by discharge requirements and permissible velocities. It shall terminate at a point well removed from any part of the embankment where the design flow may be discharged without damage to the earth embankment.

Where the earth spillway is the principal spillway, it must convey the designed discharge throughout its length to the channel below and fall within the range of permissible velocities.

2. Specification Guide

Specifications shall be in keeping with the preceding standard, shall describe the requirements for proper installation of the practice to achieve its intended purpose, and shall include consideration of the following items:

The foundation area shall be cleared of all trees, stumps, roots, brush, boulders, sod, and debris. All channel banks and sharp breaks shall be sloped to no steeper than 1:1. All topsoil containing excessive amounts of organic matter shall be removed. The surface of the foundation area will be thoroughly scarified before placement of the embankment material.

The cutoff trench shall be excavated to the lines and grades shown on the plans and shall be backfilled with suitable material in the same manner as specified for earth embankment. The trench shall be kept free of standing water during backfill operations.

Existing stream channels crossing the foundation area shall be sloped no steeper than 1:1 and deepened and widened as necessary to remove all stones, gravel, sand, stumps, roots, and other objectionable material and to accommodate compaction equipment. Such channels shall then be backfilled with suitable material as specified for earth embankment.

The spillway pipe conduit shall be placed on a firm foundation to the lines and grades shown on the plans. Selected backfill material shall be placed around the conduit in layers and each layer shall be thoroughly compacted.

The completed spillway excavation shall conform to the lines, grades, bottom width, and side slopes shown on the plans as nearly as skillful operation of the excavating equipment will permit.

All borrow areas outside the pool area shall be graded and left in a manner that they are well drained.

The material placed in the fill shall be free of all sod, roots, frozen soil, stones over 6 inches in diameter, and other objectionable material. The placing and spreading of the fill material shall be started at the lowest point of the foundation and the fill shall be brought up in approximately horizontal layers of such thickness that the required compaction can be obtained with the equipment used. The construction equipment shall be operated over the area of each layer in a way that will result in the required compaction. Special equipment shall be used when the required compaction cannot be obtained without it.

The distribution and gradation of materials throughout the fill shall be such that there will be no lenses, pockets, streaks, or layers of material differing substantially in texture or gradation from the surrounding material. Where it is necessary to use materials of varying texture and gradation, the more impervious material shall be placed in the upstream and center portions of the fill.

The moisture content of fill material shall be such that the required degree of compaction can be obtained with the equipment used.

A protective cover of vegetation shall be established on all exposed surfaces of the embankment, spillway, and borrow areas to the extent practicable under prevailing soil and climatic conditions. The embankment and spillway shall be fenced where necessary to protect the vegetation.

Seedbed preparation, seeding, sodding, fertilizing and mulching shall comply with Ohio Technical Standard and Specifications - IV-A-9. (Ditch Bank Seeding)

Earth embankments, vegetated spillways and pond areas shall be protected from grazing damage.

If permanent fences are built around the pond areas, they shall be placed at least 30 feet from the edge of the permanent pool. At points where major concentrations of runoff enter the pond, the fence shall be placed at least 60 feet from the edge of the permanent pool.

Where necessary to meet specific conditions or to incorporate new technical information, changes may be made in these standards when they are in accordance with sound engineering principles and are approved by an engineer of the Soil Conservation Service authorized to give such approvals.

C. EXCAVATED PONDS

1. Design Criteria

a. Side slopes - Side slopes of excavated ponds shall be such that they will be stable and shall not be steeper than 1 horizontal to 1 vertical. Where livestock will water directly from the pond, a watering ramp of ample width shall be provided. The ramp shall extend to the anticipated low water elevation at a uniform slope no steeper than 4 horizontal to 1 vertical.

b. Inlet protection - Where surface water enters the pond in a natural or excavated channel, the side slope of the pond shall be protected against erosion by grading to a slope no steeper than 4:1 and protecting with vegetation.

2. Specification Guide

Specifications for excavated ponds shall be in keeping with the preceding standard, shall describe the essential requirements for proper installation of the practice to achieve its intended purpose, and shall include consideration of the following items:

The completed excavation shall conform to the lines, grades, and elevations shown on the plans as nearly as can be achieved by skillful operation of the excavating equipment.

The material excavated from the pond shall be placed in one of the following ways so that its weight will not endanger the stability of the pond side slopes and where it will not be washed back into the pond by rainfall:

a. Uniformly spread to a height not exceeding three (3) feet with the top graded to a continuous slope away from the pond.

b. Uniformly placed or shaped reasonably well with side slopes no steeper than 2:1 behind a berm width equal to the depth of the pond, but not less than twelve (12) feet.

Working Tools

a. Runoff chart, Part 3, Pg. 2, Engineering Handbook for Soil Conservationists, and Pg. 301 and 302, Ready Reference.

b. Soil Infiltration Factors for Ohio Soil Groups, dated April, 1962 in the Work Unit Soil Survey Handbook.

c. Stage Requirements for Farm Ponds, Drawing 3-L-26438, Part 4, Pg. 5, Engineering Handbook for Soil Conservationists, and Pg. 445, Ready Reference.

d. Drawings, Part 4, Pg. 7-16, Engineering Handbook for Soil Conservationists.

e. Stock Water Supply System, Drawing 3-L-12248, Part 4, Pg. 20, Engineering Handbook for Soil Conservationists.

f. Earth Fill Computation, Part 1, Pg. 36 and 37, Engineering Handbook for Soil Conservationists, and Pgs. 448 through 454, Ready Reference.

g. General Specifications for Small Earth Fill Dams, Drawing 3-L-7261, and Pgs. 446 and 447, Ready Reference.

h. Ohio Engineers Handbook.

i. Technical Specifications.

j. E&WP Unit Memoranda.

References

a. Engineering Handbook for Soil Conservationists, Parts 3, 4 and 10.

b. Ready Reference.

c. Ohio Engineers Handbook.

d. Make Your Farm Pond Safe - Prevent Drownings, 1961, PA 396.

e. Managing farm fish ponds for bass and bluegills, 1955, F 2094.

f. Trout in Farm and Ranch Ponds, 1961, Farmers Bulletin No. 2154.

Soil Conservation Service, Columbus, Ohio - July, 1963

OHIO TECHNICAL STANDARD AND SPECIFICATIONS

For

GRASSED WATERWAY

Or

Outlet

1. Definition

A natural or constructed waterway or outlet shaped or graded and established in suitable vegetation as needed for the safe disposal of runoff from a field, diversion, terrace, or other structure.

2. Purpose

To provide for the disposal of excess surface water from terraces, diversions, or from natural concentrations without damage by erosion or flooding.

3. Conditions Where Practice Applies

These practices apply to all sites where added capacity or vegetative protection, or both, are required to control erosion resulting from concentrated runoff and where such control can be achieved by these practices alone, or in combination with others.

4. Design Criteria

a. Capacity - The minimum capacity shall be that required to confine the peak runoff expected from a storm of 10-year frequency except that on slopes of less than 1 percent, out-of-bank flow may be permitted where such flow will not cause erosion. The minimum in such cases shall be the capacity required to remove the runoff taken from the applicable drainage curve as specified in the Drainage Standards.

Ten-year frequency runoff may be determined from Drawing No. 3-L-14054.

b. Velocity - Design velocities shall not exceed those as determined from Chart 3-1-45288, "Design Velocities for Vegetated Channels." Velocities exceeding 5 feet per second shall be used only where good covers and proper maintenance can be attained. Values of "n" will be based on recommendations as given in SCS-TP-61, "Handbook of Channel Design for Soil and Water Conservation, revised June 1954."

c. Width - The bottom width of trapezoidal waterways or outlets shall not exceed 100 feet unless multiple or divided waterways or other means are provided to control meandering flows.

d. Depth - The minimum depth of a waterway or outlet receiving water from terraces, diversions or other tributary channels shall be that depth required to keep the design water surface elevation in the waterway or outlet at, or below, the design water surface elevation in the terrace,

diversion, or other tributary channel at their junction when both are flowing at design depth.

e. Freeboard - A minimum of .3 foot freeboard shall be provided in constructed waterways or outlets. Freeboard is not required in waterways or outlets located in natural draws or on slopes of 1 percent or less where overflow is permissible.

f. Drainage - Tile or other suitable subsurface drainage measures shall be provided for in the design for sites having high water table or seepage problems, except where water-tolerant vegetation such as Reed Canary-grass can be used to effectively alleviate this problem.

5. Specifications Guide

Specifications will be in keeping with the preceding standard, will describe the requirements for proper installation of the practice to achieve its intended purpose, and will include consideration of the following items:

All trees, brush, stumps and other objectionable material shall be disposed of so they will not interfere with construction or proper functioning of the waterway or outlet.

The waterway or outlet shall be shaped or constructed to the specified dimensions, free of bank projections or other irregularities.

Where establishment of vegetation is a problem on subsoil, topsoil from the area should be preserved by stockpiling. After the waterway has been constructed to proper grade and cross section, allowing space for the topsoil, the topsoil can then be spread over the area of the channel to be seeded.

All earth removed and not needed in construction of the waterway or outlet shall be spread or disposed of so it will not interfere with the functioning of the waterway.

Where possible, water shall temporarily be diverted from newly prepared waterways until the vegetation is well established.

Fills shall be compacted as needed to prevent unequal settlement that would cause damage in the completed waterway. Waterway or outlet seeding shall be in accordance with Ohio Agronomy Standard on Grassed Waterway or Outlet, IV-A-19a.

Critical areas, such as sod chutes, unstable soil areas, or other conditions which would cause channel scour, require special attention.

The use of sod erosion net, jute netting, fiber glass blankets or other acceptable protective devices should be considered.

6. Working Tools

a. Engineering Handbook for Soil Conservationists, Parts 3 and 10.

b. Ready References.

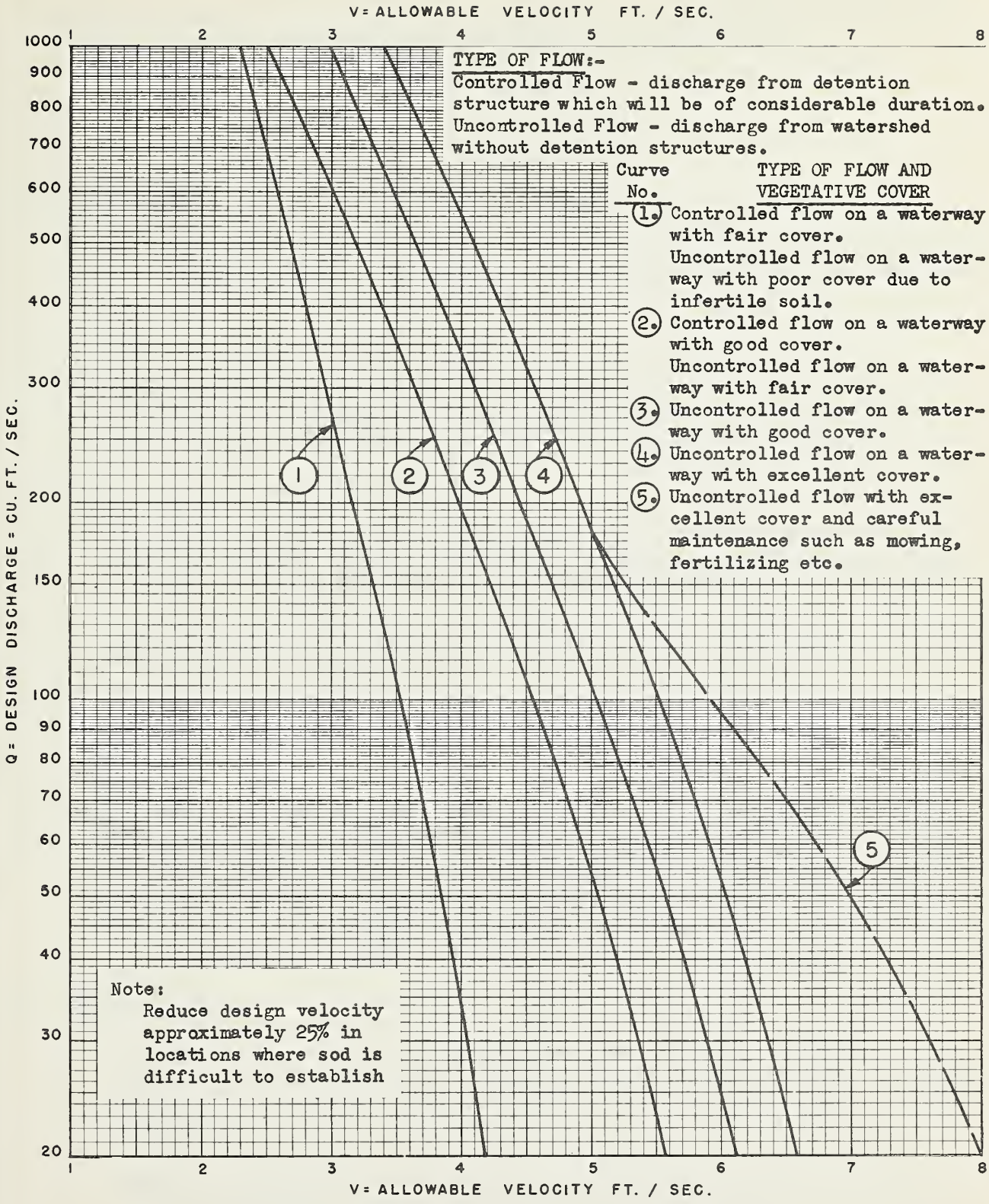
c. Grass Waterways in Soil Conservation, USDA Leaflet, L 477, 1960.

d. Terrace Outlets and Farm Drainage Ways, USDA Farmers' Bulletin F-1814, 1939, Rev. L946.

e. Handbook of Channel Design for Soil and Water Conservation, SCS-TP-61 (Rev. June 1954).

f. Chart Dwg. No. 3-L-45288, Design Velocities for Vegetated Channels, Pg. 37.

Soil Conservation Service, Columbus, Ohio, July 1963



DESIGN VELOCITIES FOR VEGETATED CHANNELS

SOIL CONSERVATION SERVICE

CORNBELT AREA

4-8-58

3-L-45288

USDA-SCS MILWAUKEE, WIS 1958

OHIO TECHNICAL STANDARD AND SPECIFICATIONS

For

IRRIGATION SYSTEM, SPRINKLER

1. Definition

A planned irrigation system where all necessary facilities have been installed for the efficient application of water for irrigation by means of perforated pipes or nozzles operated under pressure.

2. Purpose

Sprinkler irrigation systems are installed to apply irrigation water efficiently and uniformly without excessive runoff or erosion, in order to maintain soil moisture within the range for optimum plant growth.

3. Conditions Where Practice Applies

a. Sprinkler irrigation plans shall be based on an evaluation of the site and the expected operating conditions. The soils and topography shall be suitable for irrigation for the proposed crops.

b. Enough good-quality water shall be available for the practical irrigation of the crops to be grown.

c. The area to be irrigated shall have adequate drainage, either natural or artificial. A high level of management should be assured for the irrigated area.

d. Sprinkler irrigation can be adapted to most crops and soils in Ohio. Sprinklers are particularly adapted for very light application for new seedings and small plants, as well as for frost protection on certain fruit and truck crops. It is not adapted to areas where high wind velocities prevail. Other irrigation methods, such as surface irrigation, should be given full consideration. For example, land suitable for surface drainage may also be suitable for surface irrigation.

4. Design Criteria

a. The design with respect to application rate, depth to irrigate, peak moisture use rate, amount to apply and time allotted to cover the area, shall be in accordance with data given in the Ohio Conservation Irrigation Guide.

b. Depth of Application - the net depth of application shall be based on the available moisture holding capacity of the soil within the root-zone depth of the crop irrigated. The gross depth shall be determined by using field application efficiencies consistent with the conservation use of water resources.

c. Capacity Requirements - In regularly irrigated areas, sprinkler irrigation systems shall have a design peak capacity adequate to meet the moisture demands of each and all crops to be irrigated within the design area.

In computing capacity requirements, allowance must be made for reasonable water losses during application periods.

Systems for special-purpose irrigation shall have the capacity to apply a stated amount of water to the design area in a specified net operating period.

d. Design Application Rate

The design rate of application shall be within a range established by the minimum practical application rate under local climatic conditions, and the maximum rate consistent with the intake rate of the soil. Where two or more sets of conditions are found in the design area, the lowest maximum application rate for areas of significant size will apply.

e. System Layout

(1) Provide for the simultaneous operation of the number of sprinklers that will discharge the design capacity of the system.

(2) The number of settings for each lateral (operating in the area requiring the shortest irrigation interval) must not exceed the number of settings per day, times the maximum number of days allowed for completing the irrigation during the peak use period.

(3) Run main lines up and down the predominant land slopes.

(4) Run laterals across slope as nearly on the contour as practical.

(5) Use split-line operation whenever practical.

(6) Plan layout to rotate multiple laterals.

f. Distribution Patterns and Spacing Requirements

A combination of sprinkler spacing, nozzle sizes, and operating pressure shall be selected that will most nearly provide the design application rate and distribution. Prevailing wind velocities and other unfavorable operating conditions also must be considered.

Where available from the manufacturers, uniformity coefficient data shall be used to select sprinkler spacing, nozzle sizes, and operating pressure. In such cases, the uniformity coefficient shall be not less than 85 percent.

In the absence of such data, sprinkler performance tables provided by the manufacturers shall be used to select the nozzle sizes, operating pressure, and wetted diameter for the required sprinkler discharge. The maximum spacing criteria in Section 15, Chapter 11, SCS National Engineering Handbook, shall be used.

For perforated pipe lines, the spacing recommendations of the manufacturer for the design application rate, number and size of perfororations, and operating pressure shall be followed.

g. Lateral Lines

Lateral lines shall be so designed that the total pressure variation at the sprinkler heads, due both to friction head and static head, will not exceed 20 percent of the design operating pressure of the sprinklers.

Except for under-tree operation, riser pipes used in lateral lines shall be long enough to prevent interference with the distribution pattern when the tallest crop is being irrigated. In no event shall riser lengths be less than specified in Section 15, Chapter 11 of the National Engineering Handbook, Soil Conservation Service.

h. Main Lines

Main lines, sub-mains and supply lines shall be designed so as to convey the quantities of water required to all lateral lines at the maximum required pressure.

Where the pressure required for sprinkler system operation is provided by pumping, main line pipe sizes shall be so selected that an economical balance between the capitalized cost of the pipe and annual pumping cost will result.

i. Pump and Power Unit

The pump capacity and the power unit shall be adequate to operate the sprinkler system efficiently when maximum capacity is being pumped against maximum total dynamic head.

5. Specifications Guide

Specifications will be in keeping with the preceding standard and will describe the requirements for proper installation of the practice to achieve its intended purpose.

6. Working Tools

a. Ohio Conservation Irrigation Guide

b. Ready Reference, Pgs. 411-412

7. References

a. Conservation Irrigation in Humid Areas, Agr. Handbook No. 107, SCS.

b. National Engineering Handbook, Section 15.

c. Engineering Handbook for Soil Conservationists, Part 12.

OHIO TECHNICAL STANDARD AND SPECIFICATIONS

For

LAND SMOOTHING

1. Definition

Removing irregularities on the land surface by use of special equipment. (Ordinarily this does not require a complete grid survey and does not include the "planing" done as the final step in Drainage Land Grading.)

2. Purpose

The purposes of land smoothing include one or more of the following: To improve surface drainage, to provide more effective management of water, to obtain uniform planting depths, to provide for more uniform cultivation, to improve equipment operation efficiency, to improve terrace alignment, and to facilitate contour cultivation.

3. Conditions Where Practice Applies

a. This practice applies on flat land or relatively flat land, with minor depressional areas (usually less than 3 inches) and/or other surface irregularities that can be shaped without excessive grading.

b. It also applies on sloping land with depressional areas (usually less than 6 inches), small ridges and humps, old terraces and other surface irregularities that can be shaped without excessive grading.

c. The soils to be smoothed shall be of such capability as to justify their use for cropland.

d. Areas having adequate topsoil depth.

4. Design Criteria

a. The smoothed surface shall slope either uniformly or at varying grades into natural or constructed outlets such as drainage field ditches, terraces, grassed waterways, and diversions.

b. The finished surface should be free of all minor depressions.

c. The length of slope shall be within allowable erosion losses.

d. Other practices if needed to reduce length of slope, length of row drainage, or frequency of overflow, shall be included in the plans for improvement.

5. Specifications Guide

a. Specifications will be in keeping with the preceding standard, will describe the requirements for proper installation of the practice to achieve its intended purpose, and will include consideration of the following items:

(1) The degree of smoothing shall be adequate to meet the objectives of the practice.

(2) Soils shall be deep enough so that, after the needed smoothing is done, an adequate usable root zone remains which will permit satisfactory crop production with the application of proper conservation measures.

(3) The ground surface should be plowed or disked slightly deeper than the topsoil prior to smoothing operations and should be free of any vegetation and trash that would reduce the effectiveness of the smoothing operation.

(4) Number of passes of a land plane or leveler needed to meet the objectives of the practice is a minimum of at least 3 passes made in different directions consisting of one pass along each of the diagonals, with the last pass generally in the direction of cultivation.

6. Working Tools

Land Smoothing for Better Surface Drainage, J.S.-27.

7. References

Engineering Handbook for Soil Conservationists, Part II, pages 53 to 57.

Soil Conservation Service, Columbus, Ohio, July 1963

OHIO TECHNICAL STANDARD AND SPECIFICATIONS

For

PUMPING PLANT FOR WATER CONTROL

1. Definition

A pumping facility installed for removing excess surface or gound water from lowlands, or for pumping from wells, ponds, streams, and other sources.

2. Conditions Where Practice Applies

a. A gravity outlet is not available or feasible.

b. Owner has a plan and is familiar with the requirements, for operating and maintaining a pumping plant.

c. Ohio drainage and water laws can be adhered to in the planning, installation, and operation of the plant.

3. Design Criteria

a. Drainage Coefficient - The entire watershed draining to the pump, including seepage, must be used in arriving at the amount of water to be pumped.

(1) Field Crops

(a) Surface Water or Surface and Tile Water - 1.0" in 24 hours (Min.).

(b) Tile Water (only) - 3/8" to 1/2" for mineral soils; 1/2" to 3/4" for organic soils or maximum capacity of existing main plus 20%. (All surface water has been diverted away from the pump.) Maximum capacity of tile will be determined using drawing 3-L-7215 (Ohio Drainage Guide).

(2) Specialty Crops

(a) Surface Water or Surface and Tile Water - 1-1/2" to 4" in 24 hours.

(b) Tile Water (only) - 1/2" to 1-1/2" in 24 hours or maximum capacity of existing main plus 20%. (All surface water has been diverted away from the pump.) Maximum capacity of tile will be determined using drawing 3-L-7215 (Ohio Drainage Guide).

b. Pump Capacity (Q)

Qgpm = C x A x 0.042 x 450
C = value in inches in 24 hours selected from a(1) and a(2) above
A = Watershed area in acres
0.042 is a factor (1" runoff in 24 hours for one acre = 0.042 c.f.s.)
450 is a factor to change c.f.s. to gallons per minute.

c. Maximum Static Head is the vertical distance in feet between the free level of the source of supply at pump "stop" position and the point of free discharge (center of pipe) or to the level of the free surface of the discharge water, whichever is greater.

d. Pump Selection

Pump selection for the installation will be done by the pump manufacturers after the required pump capacity, total static head, and length of discharge pipe necessary have been determined. In cases where centrifugal pumps might be used, the suction head and the length of the intake pipe should also be furnished.

e. Pump Storage (Ditch or Pump Bay)

Automatic Operations

Active water storage shall be provided to supply the pump. The recommended active storage which will permit a maximum of ten cycles of operations per hour may be estimated from the following formulas:

$$\text{Active Storage in Cu. Ft.} = \frac{\text{Pump Capacity in G.P.M.}}{5}$$

(Larson -- Minn.)

$$\text{Storage Area in Sump or Ditch (Sq. Ft.)} = \frac{\text{Pump Capacity in G.P.M.}}{5d\ (\text{feet})}$$

(Larson -- Minn.)

Where "d" is the depth of storage or the distance between the water levels where the pump will start and stop operations.

f. Manual Operation

Active water storage for manual operation must be greater than for automatic operation. It depends upon the number of times the operator desires to start the pump. Where the number of starts is limited to two a day, the following formula may be used to estimate the active storage desirable:

Active Storage in Cu. Ft. = Pump Capacity in G.P.M. x 25

$$\text{Storage area in sump or ditch (Sq. Ft.)} = \frac{25 \times \text{Pump Capacity in G.P.M.}}{d(\text{feet})}$$

Where "d" is the depth of the ditch, available for water storage.

g. Pump Bay

Proper clearance and submergence must be provided in the pump bay for the pump selection. Manufacturers' recommendations for clearances and submergence should be followed. Where shop pumps are used and no clearance specifications are given, 1.5 times the pump diameter plus 10 inches for bottom clearance (when strainer is not used) should be used.

h. The plant shall be protected from flood damage or located where it will not be subject to flooding.

4. Specifications

a. Pumping plants shall be planned as an integral part of the drainage system it serves.

b. Detailed plans shall be prepared for the pumping installation and will include information to show "start", "stop", and discharge elevations, maximum static head, design discharge, length and kind of discharge pipe (if design is influenced), and active storage requirements. Suction head and length of intake pipe should be included for centrifugal pump installations.

c. The pump and power unit shall be adequate to pump the design capacity effeciently when operating at the maximum static head.

d. Provisions shall be made in the plans for including manufacturers' recommendations for clearance and submergence for the specific pump selected.

5. Working Tools

Tile Drainage Chart, Drawing No. 3-L-7215.

6. References

Design and Operation of Drainage Pumping Plants, Technical Bulletin No. 1008, May, 1950.

Soil Conservation Service, Columbus, Ohio, July 1963

OHIO TECHNICAL STANDARDS AND SPECIFICATIONS

For

SPRING DEVELOPMENT

1. Definition

Improving springs and seeps by excavating, cleaning, capping, or providing collection and storage facilities.

2. Purpose

Spring developments usually are made to improve the distribution or to increase the quantity of livestock water supplies.

3. Conditions Where Practice Applies

a. Springs or seepage areas that appear able to furnish a dependable supply of suitable water during the planned period or periods of use.

(1) Perched or contact springs occur where an impermeable layer outcrops beneath a water-bearing permeable layer.

(2) Tubular springs occur where water issues from a single opening, such as solution channels found in soluble rock formations.

(3) Fracture springs occur where water issues from rock fractures.

(4) Artesian springs occur where water under head or pressure appears near, on, or above the ground (water source is usually a water-bearing permeable layer).

4. Design Criteria

a. Perched or contact springs shall be developed by intercepting and collecting the flow from the water-bearing formation to a collection basin.

b. Collecting trench for perched or contact springs shall be at least 24 inches wide and dug to a depth that extends into the impervious layer (except for solid rock or thin impervious layers) not less than 6 inches and backfilled with 4 inches of well graded gravel or stone filter material, smoothed to grade of collector system. An impervious cut-off wall of well tamped clay, masonry or concrete should be placed on down-side of trench to block flow and cause it to enter collector system. Filter material should not be less than 6 inches thick on the sides and top of collector system.

c. The collection system for perched or contact springs shall consist of drain tile or perforated pipe of not less than 4 inches in diameter. An exception is where the impervious layer is solid rock. In such cases, crushed rock or gravel at least 15 inches square in area may

be used in lieu of tile or perforated pipe. The outlet of the collection system shall be water tight, and a concrete anti-seep cut off wall at least 8 inches thick or a tamped clay wall at least 2 feet thick shall be installed. A grade of at least 0.1% shall be provided throughout the collection system.

d. Tubular springs shall be cleaned or enlarged as needed. A collection system usually will not be required, but a collection basin shall be installed at an elevation low enough that water will not pond over the spring opening to a depth that will materially reduce the yield.

e. Where water issues from fractures, the individual openings shall be cleaned and enlarged as needed to provide an increase in flow. The water from these individual openings shall be collected and conveyed to a collection basin by means of tile or perforated pipeline or by a gravel-filled ditch. The collection works shall be constructed enough below the elevation of the openings to permit free discharge.

f. Artesian springs shall be developed by removing obstructions, cleaning or enlarging joints or fractures, or by lowering the outlet elevation. Collection basin or spring box shall be located so as to hold ponding over the spring outlet to a minimum.

g. Collection basins (spring boxes) of durable inert material shall be provided for all springs. Concrete (monolithic or precast), masonry, sections of metal, concrete or glazed clay culvert pipe may be used. Collection basins shall have a minimum cross sectional area of $1\frac{1}{2}$ square feet and be fitted with a tight, removable cover.

Collection basins for perched springs shall be floored with concrete unless the underlying material is solid rock or other stable impervious material.

h. The outlet pipe leaving the collection basin shall be placed not less than 6 inches above the floor of the collection basin. The inlet elevation of the outflow pipe shall be such that it will not cause a head on the spring and cause reduction or stoppage of flow. A water-tight connection must be made where the pipe leaves the collection basin.

Minimum size of outlet pipe:

Hand-drawn copper or plastic tubing - 1 inch diameter

Wrought iron or galvanized steel or iron - $1\frac{1}{4}$ inch diameter

The outlet pipe shall be laid with a grade(s) of at least 0.5% without sags or high spots.

i. Consider installation of overflow pipe out of collection basin when overflow of collection basin is considered a significant problem. (Assuming location and depth of collector basin and outlet pipe was designed to take care of normal variations in head or flow.)

j. Measures required to protect the development from drainage by freezing, flooding, sedimentation, contamination, and livestock shall be included in the design.

5. Specifications Guide

Specifications will be in keeping with the preceding standard, will describe the requirements for proper installation of the practice to achieve its intended purpose, and will include consideration of the following items:

a. All loose rock, sediments, logs, and vegetation that obstruct the free discharge of the spring shall be removed and disposed of so that they will not endanger the spring development.

Collection trenches, drain tiles, perforated pipe lines, and collection basins shall be constructed to the elevations and grades shown on the plans.

Crushed rock or gravel for collection systems and sand-gravel material for filters shall be composed of clean, hard particles.

Overflow pipe from tanks (and collection basin, if needed) shall be outletted at a sufficient distance from water tank so as not to create a sloppy and muddy condition around the tank.

Divert surface waters by diversion. Tanks shall be located so as to permit ready access by livestock and adequate surface drainage in the vicinity of the tank.

6. Working Tools

a. Spring Development for Livestock Use, J.S. 28.

7. References

a. Engineering Handbook for Soil Conservationists, Part 5.

Soil Conservation Service, Columbus, Ohio, July 1963

OHIO TECHNICAL STANDARD AND SPECIFICATIONS

For

TERRACE, GRADIENT (Graded)

1. Definition

An earth embankment or a ridge and channel constructed across the slope at a suitable spacing and with an acceptable grade.

This standard does not apply to Diversions and Surface Drainage.

2. Purpose

Gradient terraces are constructed to reduce erosion damage by intercepting surface runoff and conducting it to a stable outlet at a non-erosive velocity.

3. Conditions Where Practice Applies

Gradient terraces normally are limited to cropland having a water erosion problem. They shall not be constructed on deep sands or on soils that are too stony, steep, or shallow to permit practical and economical installation and maintenance. The topography must be such that farmable terraces can be constructed. Gradient terraces may be used only where suitable outlets are, or will be, made available.

4. Design Criteria

a. Spacing

The maximum spacing of gradient terraces shall be determined by the equation:

$$VI = .7S+2$$

VI = Vertical Interval in feet
S = Landslope in feet per 100 feet (%)

Table No. 1 gives vertical and horizontal intervals, for average land slopes, as computed when using this formula.

Vertical spacings determined may be increased as much as 10 percent or 0.5 foot to provide better alignment or location, to miss obstacles in the field, to adjust for farm machinery, or to reach a satisfactory outlet.

The drainage area above the top terrace shall not exceed the area that would be drained by a terrace of equal length with normal spacing.

Note: Where this drainage area requirement is impractical to meet, a diversion may be installed above the land to be terraced.

TERRACE SPACING

Table 1

Average Land Slope %	Vertical Interval Feet	Horizontal Spacing Feet	Parallel Terraces	
			Horizontal Spacing Feet	No. of 40-inch Crop Rows
1	2.7	270	280	84
2	3.4	170	173	52
3	4.1	137	147	44
4	4.8	120	120	36
5	5.5	110	120	36
6	6.2	103	107	32
7	6.9	99	107	32
8	7.6	95	107	32
9	8.3	92	93	28
10	9.0	90	93	28
11	9.7	88	93	28
12	10.4	87	93	28

b. Alignment

Terraces in a system shall be made as nearly parallel as practicable. Land smoothing, a moderate amount of cutting and filling along the terrace line, use of multiple outlets, variations in grades, and other methods shall be used as needed to improve alignment. Care should be used in planning so as to avoid exposing excessive amounts of subsoil.

c. Length

Maximum length of terrace draining in one direction shall be 1000 feet.

d. Capacity

The terrace shall have capacity to carry the peak runoff expected from a 10-year-frequency storm as a minimum, with a freeboard not less than 0.3 foot.

e. Cross Section

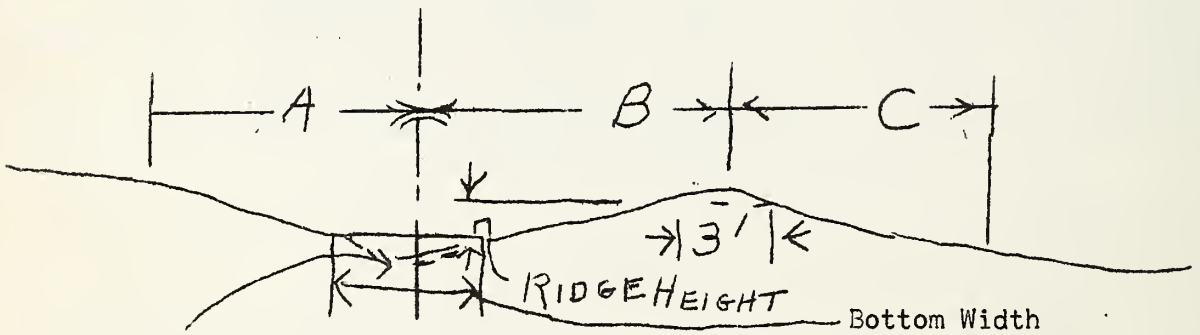
The terrace cross section shall be proportioned to fit the land slope, the crops grown, and the farm machinery used. The ridge shall include a reasonable settlement factor. The ridge shall have a minimum top width of three feet at the design height. The minimum cross-sectional area of the terrace channel shall be the minimum ridge and channel dimensions as determined from Table 2.

CHANNEL AND RIDGE DIMENSIONS

Table 2

Average Land Slope	Bottom Width	Ridge Height * Terrace Length					Cross Section Dimensions			
		200'	400'	600'	800'	1000'	A	BB	C	Total
2	4	.8	.9	1.0	1.1	1.1	14'	15'	15'	44'
	6	.8	.9	1.0	1.0	1.0	"	"	"	"
	8	.8	.8	.9	.9	.9	"	"	"	"
4	4	.8	.9	1.0	1.0	1.1	"	"	"	"
	6	.8	.8	.9	.9	1.0	"	"	"	"
	8	.8	.8	.8	.9	.9	"	"	"	"
6	4	.8	.8	.9	1.0	1.0	"	"	"	"
	6	.8	.8	.8	.9	.9	"	"	"	"
	8	.8	.8	.8	.8	.9	"	"	"	"
8	4	.8	.8	.9	.9	1.0	15'	12'	15'	42'
	6	.8	.8	.8	.8	.9	"	"	"	"
	8	.8	.8	.8	.8	.8	"	"	"	"
10	4	.8	.8	.9	.9	1.0	"	"	"	"
	6	.8	.8	.8	.8	.9	"	"	"	"
	8	.8	.8	.8	.8	.8	"	"	"	"
12	4	.8	.8	.8	.9	.9	"	"	"	"
	6	.8	.8	.8	.8	.9	"	"	"	"
	8	.8	.8	.8	.8	.8	"	"	"	"

* Includes 0.3' freeboard. (settled Height)



V-type construction is permissible if sufficient depth is obtained to result in the channel bottom width called for in design

f. Channel Grade

Normally terraces shall be staked on grades ranging from a minimum of 0.2 foot per 100 feet of length and a maximum of 0.6 foot per 100 feet. Grades may be either uniform or variable. For the purpose of improving alignment, terrace grades may be increased as follows:

(1) Grades up to 1.0 foot per 100 feet for a continuous length of 200 feet or less.

(2) Grades up to 1.5 feet per 100 feet for a continuous length of 100 feet or less.

(3) Grades up to 3.0 feet per 100 feet for the upper 100 feet or less where drainage area contributing to the channel does not exceed the area that would be drained by a terrace of 100 feet in length with normal spacing.

g. Outlet

All gradient terraces must have an adequate outlet. Such an outlet may be a natural grassed waterway or a vegetated area. In all cases, the outlet must convey runoff from the terrace or terrace system to a point where the outflow will not cause damage. The use of several outlets for a terrace system is desirable to maintain safe velocities in the outlets and terraces, to reduce the possibility of overtopping, and to permit construction of channels that facilitate efficient operation of modern farm equipment.

The design elevation of the water surface in the terrace shall not be lower than the design elevation of the water surface in the outlet, at their junction, when both are operating at design flow.

Prior approval shall be obtained by the landowner when terraces outlet on to the right-of-way of a public road or highway or other public utility. Ohio drainage or water laws shall be adhered to in the diversion and disposal of terrace water.

5. Specifications Guide

Specifications will be in keeping with the preceding standard, will describe the requirements for proper installation of the practice to achieve its intended purpose, and will include consideration of the following items:

All dead furrows, ditches, or gullies to be crossed shall be filled before construction begins or as a part of construction. All old terraces, fencerows, and other obstructions that will interfere with the successful operation of the system shall be removed.

The minimum constructed cross section shall meet the design dimensions.

The top of the constructed ridge shall not be lower at any point than the design elevation plus the specified overfill for settlement. The opening at the outlet end of the terraces shall have a cross section equal to, or exceeding, that specified for the terrace channel.

The finished channel shall contain no depressional areas which would cause ponding of water injurious to crops.

Secondary channels below the terrace ridge created during construction shall be obliterated.

Farm equipment operations must essentially be parallel to the terraces. A cooperator should fully understand his plan for operating farm equipment in the terraced field and his plan for maintaining the terraces, prior to construction of the system.

Terrace outlets shall be installed before terrace construction if necessary to insure vegetative cover in the outlet channel.

The location of farm roads must be considered in the planning and applying of terrace systems.

6. Working Tools

   a. Construction Charts, Part 8, pp. 6-12, Engineering Handbook for Soil Conservationists.

   b. Construction Charts, pp. 346-360, Ready Reference.

   c. Planting Row Crops on Terraced Land, J.S. 14.

   d. Plow Terraced Land With Two-Way Plows, J.S. 15.

   e. How to Plow Terraced Land With One-Way Plows, J.S. 16.

   f. Harvesting Crops on Terraced Land, J.S. 17.

   g. A Method of Terrace Construction Plowing From Upper Side Only, J.S. 23.

   h. A Method of Terrace Construction Plowing From Both Sides, J.S. 24.

   i. Method of Construction With Two Bottom Plows, J.S. 25.

   j. Terrace or Diversion Construction With a Bulldozer, J.S. 42.

7. References

   a. Engineering Handbook for Soil Conservationists, Part 8.

   b. Ready Reference.

   c. Farming Terraced Land, USDA Leaflet L-355, 1961.

OHIO TECHNICAL STANDARD AND SPECIFICATIONS

For

TILE DRAINS

1. Definition

A covered drain, such as tile or pipe, of suitable size installed beneath the surface of the ground to a planned grade and depth.

2. Purpose

A tile drain may serve one or more of the following purposes: (1) to lower the water table level, (2) intercept and prevent water movement into a wet area, (3) relieve artesian pressures, (4) remove surface runoff, and (5) serve as an outlet for other tile drains.

3. Conditions Where Practice Applies

Tile drainage should be used in areas having a high water table where benefits of lowering or controlling ground water or surface runoff justify the installation of such a system.

All lands to be drained shall be suitable for agricultural use within their capabilities after installation of required drainage and other conservation practices. The soil shall have enough depth and permeability to permit installation of an effective and economically feasible system.

An outlet for the drainage system shall be available, either by gravity flow or by pumping. The outlet shall be adequate for the quantity and quality of water to be disposed of with consideration of possible damages above or below the point of discharge. Ohio drainage and water laws shall be adhered to in the planning and installation of tile drains.

4. Design Criteria

a. Required Capacity of Tile Mains (Size of mains)

(1) The size of tile mains shall be determined from Tile Drainage chart No. 3-L-7215 or computed by applying Manning's or Yarnell's formula as covered in the National Engineering Handbook, Section 16, Drainage, Chapter 4. When the drainage chart is used the following drainage coefficients shall be used:

Where the land to be drained has complete surface drainage, either natural or artificial.

SOILS	Coefficient	
	Drainage Field Crops	Drainage Truck Crops
Mineral	3/8 to 1/2	1/2 to 3/4
Organic	1/2 to 3/4	3/4 to 1-1/2

Where it is necessary to admit surface water to the tile system through surface inlets.

SOIL	Coefficient			
	Drainage Field Crops		Drainage Truck Crops	
	Blind Inlets	Open Inlets	Blind Inlets	Open Inlets
Mineral	1/2 to 3/4	1/2 to 1	3/4 to 1	1 to 1-1/2
Organic	1/2 to 1	1/2 to 1-1/2	3/4 to 2	2 to 4

Where high value truck crops might be damaged by water standing on them from 2 to 4 hours during hot weather, a higher coefficient than those given above may be necessary to hold crop damage to a minimum.

(2) Normally the minimum size of mains should be 6".

b. Required capacity of interceptor drains.

(1) Where springs or seepage are to be intercepted, the tile size may be determined on the basis of the estimated flow, or computed as outlined in the National Engineering Handbook, Section 16, Drainage, Chapter 4.

c. Required capacity of tile laterals.

(1) The capacity of tile laterals shall equal or exceed the drainage coefficient used for the main. The minimum size tile for laterals is 4 inches.

(2) Five-inch tile should normally be used in sandy soils and may be considered for use in organic soils. If used in organic soils, the length of tile should be a minimum of two feet.

(3) Six-inch tile, a minimum of two feet long, should normally be used in organic soils.

(4) For convenience the following table lists maximum length of 4" laterals for various spacings and grades when using a 3/8" coefficient.

MAXIMUM LENGTH OF 4" LATERALS IN FEET - 3/8" COEFFICIENT

Lateral Spacing in Feet	Grade		
	0.10% to 0.14%	0.15% to 0.20%	Over 0.20%
Less than 60'	2640	2640	2640
60' to 66'	2300	2640	2640
67' to 75'	2000	2500	2640
76' to 85'	1800	2100	2500
86' to 100'	1500	1800	2100
101' to 125'	1200	1500	1700

d. Determining Acres drained for use with Tile Chart No. 3-L-7215

The following guides should be used in determining acres drained and whether the tile will carry subsurface water only or both surface and subsurface water:

(1) Where no surface water is admitted directly to the tile system:

(a) The selected drainage coefficient applies only to the wetland area needing tile drainage.

(b) If the runoff from the upland watershed cannot be diverted from or channeled through the area tiled, the drainage coefficient should be applied to the entire watershed if the permeability of the soil permits the water to seep into the tile at a rate to justify the capacity.

(2) When surface water is admitted directly to the tile line through surface inlets:

(a) The selected drainage coefficient applies to the entire watershed contributing to the surface inlets.

(b) An exception to item 2a is where only a small amount of runoff will be impounded at the location of the inlet and the rest will flow away in an open channel. The tile line should be designed to carry away the impounded water within 6 to 24 hours depending on the crop to be protected.

e. Depth and Spacing - See element standard and specifications: "Depth and spacing of tile and spacing of drainage field ditches" or the Ohio Drainage Guide.

f. Minimum cover over tile.

(1) The minimum depth of cover over tile in mineral soils shall be 24 inches. This minimum depth shall apply to normal field levels and may exclude sections of line near the tile outlet, or sections laid through minor depressions where the tile is not subject to damage by frost action or equipment loading.

The minimum depth of cover in organic soils shall be 30 inches for normal field levels as defined above after initial subsidence.

Conduits under roadways and where the above requirements cannot be met shall be designed to withstand the expected loads.

g. Tile Grades:

(1) Minimum Grade

(a) 4-inch tile 0.10%
(b) 5-inch tile 0.07%
(c) 6-inch and larger tile 0.05%

Under exceptional conditions, grades less than those shown have been justified where the soil was cohesive and where the quality of installation and local experience indicated that lesser grades would give satisfactory performance.

(2) Maximum grade (mains)

Special construction features shall be used, as outlined in the National Engineering Handbook, Section 16, Drainage, Chapter 5, when the grades exceed the limitations outlined in the following table:

Maximum grade of mains using normal construction methods:

Soil Texture	Tile Size		
	5" & 6"	8" & 10"	12" & 15"
Sand and sandy loam	0.75%	0.40%	0.20%
Silt and silt loam	1.50%	0.75%	0.40%
Silty clay loam	3.00%	1.00%	0.50%
Clay & clay loam	4.00%	1.50%	0.75%

When grades in high clay content soils exceed the above values, tile laid to a tight fit and good alinement may be all that is required.

h. Tile - Kinds and Quality

Drain tile shall meet current specifications of the American Society for Testing Materials. The use of concrete tile under acid and sulfate conditions shall be in accord with the guide in Table 5-2, Chapter 5, Section 16, of the National Engineering Handbook.

i. Loading

Loads on conduits for usual tile and trench conditions shall be determined in accordance with procedures in Chapter 5, Pages 5-9 to 5-16, Section 16, National Engineering Handbook. The maximum allowable depth shall be computed using a safety factor of not less than 1.50. Where load conditions are other than those covered by this Chapter, loads shall be computed in accordance with SCS Technical Release No. 5.

j. Foundation Requirements

Soft or yielding foundations shall be stabilized where required and lines protected from settlement by (1) adding gravel or other material to the trench, (2) placing tile on plank or other rigid supports, or (3) using sections of perforated or watertight pipe.

k. Blinding

All tile shall be "blinded" with topsoil or other approved material immediately after the tile are laid

l. Tile Outlets

(1) When tile mains outlet into open ditches, a 12-inch clearance should be provided between the bottom of the tile at outlet and growing season normal water level in the open ditch. This clearance may be reduced where one or more of the following conditions exist:

(a) Average grade of lower portion of the tile main (300 ft. or more) exceeds 0.20%

(b) Average grade of ditch below tile outlet (300 ft. or more) exceeds 0.20%

(c) Most of benefited surface area is located 5 feet or more above the invert of the tile outlet.

(d) Ditch has not been "deepened" or maintained recently but it is reasonable to assume from drainage history and plans for the area that work will be done in the near future.

(e) There is no low-water flow in the ditch for more than a few hours after storms.

(f) When tile outlets into Lake Erie or its backwater, the top of the outlet tile for gravity drainage should be 1.25' above the average high water stage during the growing season or 573.00 (lake level - U.S.G.S.) plus 1.25 equals 574.25 above sea level.

(2) When tile outlet into an open ditch, the tile shall be protected against erosion and undermining.

(a) Where no surface water will enter the ditch at the tile outlet, use a section of continuous, substantially watertight pipe such as corrugated metal pipe, well casing, transite pipe, or other pipe of equal or better quality. Minimum lengths of pipe in feet varying with tile size and freeboard (vertical distance from ditch bottom to invert of tile outlet) are stated in the following table:

MINIMUM LENGTH OF OUTLET PIPE

Freeboard (Ditch bottom to tile invert)	Tile Size		
	4" & 5"	6" & 8"	10" & over
Under 2 feet	8 ft.	12 ft.	16 ft.
2 feet and over	10 ft.	16 ft.	20 ft.

Not more than 1/3 of outlet pipe should extend beyond ditch bank.

(b) Protection must be provided for exclusion of animals for 6" and larger tile. Protection should also be considered for 4" and 5" tile, depending on circumstances and site conditions.

(c) Where surface water enters the ditch at the location of the tile outlet, an approved type of structure shall be used to safely lower the surface water to the ditch and outlet the tile.

(3) When existing tile mains are used as outlets, they shall have sufficient capacity to handle the total area served using the applicable drainage coefficient as specified under paragraph 4a (1); the main shall be in good condition; minimum cover requirements should be as specified under paragraph 4f.

m. Junctions and Connections

(1) The connection between two tile lines should be made with manufactured junctions, either Y or T. If connections are fabricated in the field, the joint should be reinforced with concrete mortar on all sides of the joint. All junctions shall be carefully made to assure a smooth, tight connection. Connect laterals to the main tile at the most convenient point, usually the mid-point of the tile. It is a practice to lay a submain parallel to a large main for collecting the lateral lines since tapping the large main every 50 or 100 feet is undesirable. Saving through eliminating large connections usually will offset the cost of the submain.

(2) Junction boxes may be used where more than two tile mains join or where two or more laterals or mains join at different elevations. Where possible, junction boxes should be located in permanent fence lines, or in noncultivated areas. The cover should be above ground to provide easy access for inspection. If the junction point is in a cultivated field, the box may be constructed so that the top is at least 18" below the surface of the ground. It can then be capped, covered with soil, and its location "referenced in" so that it can readily be located.

n. Surface Inlets and Blind Inlets

Surface inlets or blind inlets (French drains) shall be used where the construction of shallow surface drains is not feasible or not practical in the removal of impounded surface water.

Where surface water is to be admitted to the tile lines, inlets should be designed to exclude debris and prevent sediment from entering the tile or conduit.

o. Alignment

(1) The change in horizontal direction may be made by one of the following methods:

(a) A gradual curve of the tile trench on a radius that the trenching machine can dig and still maintain grade.

(b) A gradual curve may be made by shaping the inner side of the curve and chipping the tile; however, in no case shall the radius of curvature be less than 5 feet.

p. Joint Spacing

Texture, etc.

Muck	- 1/8" to 3/8"
Clay soils	- 1/8" to 1/4"
Loamy soils	- 1/8"
Sandy soils	- lay to a tight fit
Mains 8" and over	- lay to a tight fit

q. Tile lines flowing under pressure

Tile lines flowing under pressure shall be designed to withstand the resulting pressures and velocity of flow. Auxiliary surface waterways shall be used where feasible.

r. Relief Wells

(1) Relief wells serve to relieve pressure, especially in mains that carry surface water. A relief well can be constructed by placing a vitrified sewer pipe "T" connection in the line and cementing sewer pipe vertically into it. The pipe should extend one foot above the ground.

The top of the tile shall be covered with heavy wire mesh or some type of grating. The size of the riser tile should be equal in diameter to the tile line or one or two sizes smaller, depending upon the amount of possible overload.

(2) Relief wells shall be located at points where the tile main might become overloaded for a short period of time, such as at a point where there is a change from a "steep" to a "flat" grade. Generally relief wells should be placed at fence or property lines.

s. Breathers or Inspection Wells

It is desirable to locate a breather or inspection well every one-fourth mile on long tile mains. Where used, they should be located at fence lines or other protected places. A breather should be constructed by using a vitrified sewer pipe "T" connection in the line and cementing small sewer pipe vertically into it. The pipe should extend approximately one foot above the ground level and the top should be covered with a heavy wire mesh or grating.

t. Trees

(1) When tile mains must be installed adjacent to trees such as willow, elm, soft maple and cottonwood, whose roots may grow into them, one of the following specifications shall be followed:

(a) The trees shall be removed for a distance of 75 feet on each side of the tile line, or

(b) Continuous "root-proof" pipe shall be used.

(2) A clearance of 50 feet shall be maintained between tile mains and other species of trees, shrubs or vines, or "root-proof" pipe shall be used.

(3) Rather than place a tile main along a woodlot, it is often possible to move it the required distance from the trees and use a parallel lateral between the main and the woodlot.

u. Surface Drainage

Surface drainage should be provided on all proposed tile drainage jobs where the natural surface drainage is inadequate.

Surface drainage facilities, such as road culverts and surface channels, should be provided where required in conjunction with tile systems to eliminate the need of surface inlets into agricultural tile drainage systems.

Where surface water runs onto tiled areas from adjacent lands means should be provided to divert it away from the area. On flood plains provisions should be made to keep the flood water off or to remove it quickly after the stream has subsided.

5. Specifications Guide

a. Specifications will be in keeping with the preceding standard, will describe the requirements for proper installation of the practice to achieve its intended purpose, and will include consideration of the following items:

(1) Tile shall be given a rigid inspection before installation.

(2) Tile shall be protected from freezing and thawing prior to installation.

(3) All material shall be satisfactory for intended use and shall meet applicable specifications and requirements.

(4) All tile shall be laid to grade and covered with approved blinding or filter material to a depth of not less than 3 inches over top of the tile. No reversals in grade of conduit shall be permitted.

(5) Earth backfill material shall be placed in the trench in such a manner that displacement or breakage of the tile will not occur. Backfilling should be completed soon after the tile are blinded.

(6) Openings wider than specified in par. 4p and occurring on the outer side of a curve in the tile line, or due to tile irregularity, will be permitted if they are covered with broken tile or other suitable material.

(7) The upper end of each tile line shall be closed with concrete or other durable material unless connected to a structure.

(8) Where the conduit is to be laid in rock trench, or where rock is exposed at the bottom of the trench, the rock shall be removed below grade enough so that the trench may be backfilled, compacted, and bedded, and when completed the conduit shall be not less than 2 inches from rock.

6. Working Tools

a. Tile Drainage chart, Drawing 3-L-7215. Also Pg. 395 Ready Reference.

b. Allowable Drain Tile Trench Depths for Wet Clay, page 38, Ohio Drainage Guide. Also Pg. 396 Ready Reference.

c. Pertinent Drain Tile Information, page 397, Ready Reference.

d. Suggestions for Good Tile Drainage, J.S. 13.

e. Laying Tile by Hand, J.S. 40.

7. References

a. Ohio Drainage Guide.

b. Engineering Handbook for Soil Conservationists, Part II, pages 58-93.

c. Ready Reference, pages 395-397.

d. Keep Your Tile Drains Working, USDA Leaflet No. 347, 1954.

e. Farm Drainage, USDA Farmers' Bulletin, No. 2046, 1952.

f. Specifications for Drain Tile, ASTM Designation.

g. Selecting Quality Drain Tile, Extension Bulletin No. 366.

h. Rules for Determining Approximate Tile Quality by K. H. Beauchamp.

Soil Conservation Service, Columbus, Ohio, July 1963